FOUNDATION INVESTIGATION AND DESIGN REPORT
CULVERTS AND OVERHEAD SIGN SUPPORTS
HIGHWAY 400 AND LINE 5 INTERCHANGE RECONSTRUCTION
BRADFORD WEST GWILLIMBURY, ONTARIO
TBWG WP P13-03
MTO GWP 2122-10-00

GEOCRES No. 31D-611

Report to

AECOM

Thurber Engineering Ltd.
2010 Winston Park Drive, Suite 103
Oakville, Ontario
L6H 5R7
Phone: (905) 829 8666
Fax: (905) 829 1166

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for the design and construction of a total of twelve culverts to be installed as part of the proposed reconstruction of the Highway 400 and Line 5 interchange in the Town of Bradford West Gwillimbury, Ontario.

The purpose of this investigation was to explore the subsurface conditions near the specific location of each culvert and, based on the data obtained, to provide borehole location plans and soil strata drawings with stratigraphic profiles, records of boreholes, laboratory test results and written descriptions of the subsurface conditions. A model of the subsurface conditions was developed for the sites based on the data obtained from the present investigation.

Thurber Engineering Ltd. (Thurber) carried out the investigation as a foundation sub-consultant to AECOM, ultimately for the Town of Bradford West Gwillimbury (TBWG).

2 PROJECT AND SITE DESCRIPTION

The culvert sites are located in the vicinity of Highway 400 at the existing Line 5, approximately 2.5 km south of the Highway 400 and Simcoe Road 88 (formerly Highway 88) interchange in the Town of Bradford West Gwillimbury, Ontario.

Location details of the culverts covered by this report are summarized in the following Table 2.1. Permission to access and drill boreholes for Culvert 13 had not been granted by the land owner at the time of investigation. In light of this situation, foundation recommendations are not provided for Culvert 13. The other proposed CSP culverts have been covered by the pavement design report.

Table 2.1 - Culvert Location Details

Culvert designation	Location	Approximate Station	Comments
1	Hwy 400/Ramp W-S	13+120	Culvert extension
3	Line 5	9+280	Culvert replacement
4	Line 5	9+795	New culvert High fill (7.0 m) to be constructed above culvert
7	Line 5	10+740	New culvert
13*	Sideroad 5	10+580	New culvert
15	Ramp W-S	10+450	Culvert extension
16	Ramp E-N	10+375	New culvert
17	Ramp W-N	10+230	New culvert
18	Ramp S-EW	10+080	Culvert extension
23	Coffey Road	10+936	New culvert
25	Coffey Road	10+460	New culvert
28	Ramps N-EW and E-S	10+490	New culvert High fill (8.2 m) to be constructed above culvert
29	Ramp N-EW	10+288	New culvert

* Not drilled due to no permission to access the site.

The lands surrounding the culverts are relatively flat and primarily used for agricultural purposes. The existing Sideroad 5 and Coffey Road run alongside Highway 400 at the southwest and southeast quadrants, respectively. The North Schomberg River meanders on the west side of Highway 400 and flows under the highway through a culvert to the north of the existing Line 5. Within the project area, vegetation cover largely consists of grass with some shrubs and small trees along the highway and Line 5. Some residential dwellings are located approximately 150 m north of the Line 5 and Sideroad 5 crossing.

From published geological information, the site is located within the physiographic region known as the Schomberg Clay Plains which consists of deep deposits of stratified clay and silt overlying a drumlinized till plain. Depending on their sizes, the drumlins are completely or partially buried by the clay and silt deposits. The clay and silt deposits have average thicknesses of about 5 m although thicker deposits have also been identified.

3 SITE INVESTIGATION AND FIELD TESTING

Details of the boreholes advanced for the twelve culverts are presented in Table 3.1. Six of the boreholes were supplemented by dynamic cone penetration testing (DCPT) conducted from the base of the sampled borehole and extended to practical refusal or selected depth below the

foundations. It is noted that the "C" series boreholes were drilled during this phase of the investigation for selected culverts. The other boreholes were advanced during previous investigation phases for this project.

Table 3.1 – Borehole Designations and Details

Culvert	Date	Borehole	Sampled Borehole termination depth* (m)	Sampled Borehole termination elevation* (m)
1	November 25, 2014	14-39*	21.9	204.7
3	November 11, 13 and 19, 2014	14-36* 14-49* 14-50*	17.6 to 20.6	203.6 to 205.2
4	May 26 and 28, 2015	C4-01 C4-02 13-24 13-25	8.2 to 13.3	208.6 to 215.2
7	May 22, 2015	C7-01 C7-02	9.8	222.1 to 223.1
15	November 17, 2014	14-37*	20.7	204.6
16	May 25, 2015	C16-01 C16-02	10.2	213.9 to 214.9
17	May 20, 2015	C17-01 C17-02	9.8 to 10.2	216.0 to 216.8
18	October 15, 16 and November 13, 2014	14-40 14-41*	11.3 to 21.2	203.0 to 214.9
23	May 21, 2015	C23-01	10.2	215.1
25	May 21, 2015	C25-01 C25-02	5.2 to 5.6	222.3 to 222.5
28	October 23, 24, 29, 30, November 4 and 5, 2014	14-15 14-16 14-17 14-51	12.6 to 20.1	202.1 to 208.9
29	May 26, 2015 December 4, 2014	C29-01 C29-02	10.2 to 11.3	212.3 to 212.6

* Borehole termination depths include termination depth of DCPT

The approximate locations of the boreholes drilled during the investigation are shown on the attached Borehole Locations and Soil Strata Drawings in Appendix C. The coordinates and elevations of the boreholes are given on the drawings and on the individual Record of Borehole Sheets in Appendix A.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling.

During this investigation, track-mounted D90, D56 and D6 drill rigs were used in the field, and a truck-mounted drill rig was used for boreholes drilled on the existing Highway 400 and Line 5 platforms. A combination of solid and hollow-stem augers were used to advance the boreholes. Wash-boring methods with casing and tripod were employed for Borehole 29-02 where drill rig access was not feasible. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). The in situ shear strength of the soft to firm cohesive soils was also assessed using the MTO shear vane. Dynamic cone penetration test (DCPT) were carried out at the bottom of selected boreholes.

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions were observed in the open boreholes during and upon completion of the drilling operations. Standpipe piezometers consisting of a 19 mm diameter Schedule 40 PVC pipe with a 3.0 m long slotted screen, were installed within filter sand in selected boreholes to permit longer term groundwater level monitoring. Completion details of the boreholes with piezometer installations are summarized in Table 3.2. Boreholes without piezometer installations were backfilled with bentonite holeplug and drill cuttings.

Table 3.2 – Piezometer and Borehole Completion Details

Culvert	Borehole Number	Piezometer Tip Depth / Elevation (m)	Completion Details
3	14-36	15.2/210.6	Backfilled with filter sand from 20.6 to 9.7 m, bentonite holeplug from 9.7 to 0.6 m, filter sand from 0.6 to 0.15 m, then asphalt to ground surface.
	14-50	15.2/208.4	Backfilled with filter sand from 18.6 to 11.3 m, bentonite holeplug from 11.3 to 8.8 m, bentonite holeplug and auger cuttings from 8.8 to 0.9 m, then bentonite holeplug to ground surface.
4	C4-02	12.2/212.2	Backfilled with filter sand from 13.3 m to 8.5 m, bentonite holeplug from 8.5 to 7.6 m, bentonite holeplug and auger cuttings from 7.6 m to ground surface.

Culvert	Borehole Number	Piezometer Tip Depth / Elevation (m)	Completion Details
	13-24	7.6/215.8	Backfilled with filter sand from 8.2 to 4.3 m, bentonite holeplug and auger cuttings from 4.3 m to ground surface.
	13-25	10.7/213.5	Backfilled with filter sand from 11.3 to 7.3 m, bentonite holeplug and auger cuttings from 7.3 m to ground surface.
7	C7-02	9.1/222.8	Backfilled with filter sand from 9.8 m to 5.5 m, bentonite holeplug from 5.5 to 4.4 m, bentonite holeplug and auger cuttings from 4.4 m to ground surface.
16	C16-01	9.3/214.8	Backfilled with filter sand from 10.2 m to 5.8 m, bentonite holeplug from 5.8 to 4.9 m, bentonite holeplug and auger cuttings from 4.9 m to ground surface.
17	C17-02	9.1/217.5	Backfilled with filter sand from 9.8 m to 5.8 m, bentonite holeplug from 5.8 to 4.6 m, bentonite holeplug and auger cuttings from 4.6 m to ground surface.
18	14-41	17.1/207.1	Backfilled with filter sand from 21.2 to 13.1 m, bentonite holeplug from 13.1 to 11.0m, bentonite holeplug and auger cuttings from 11.0 to 0.9 m, then bentonite holeplug to ground surface.
25	C25-02	4.6/222.9	Backfilled with filter sand from 5.2 m to 2.7 m, bentonite holeplug from 2.7 to 1.8 m, bentonite holeplug and auger cuttings from 1.8 m to ground surface.
28	14-16	12.8/208.4	Backfilled with filter sand from 13.3 to 9.4 m, bentonite holeplug from 9.4 m to ground surface.
	14-17	12.5/209.0	Backfilled with filter sand from 13.3 to 8.9 m, bentonite holeplug from 8.9 to 5.2 m, then bentonite holeplug and auger cuttings to ground surface.
29	C29-01	9.1/213.7	Backfilled with filter sand from 10.2 m to 7.2 m, bentonite holeplug from 7.2 to 5.8 m, bentonite holeplug and auger cuttings from 5.8 m to ground surface.

Once groundwater monitoring is completed, all piezometers will be decommissioned in accordance with Ministry of the Environment Regulation 903 and its Amendments (the water well regulation under the OWRA).

4 LABORATORY TESTING

All recovered soil samples were subjected to visual identification and to natural moisture content determination. At least 25% of the recovered soil samples were subjected to grain size distribution analysis. Atterberg Limits tests were carried out on selected samples of native silty clay to determine the plasticity characteristics. The results of the laboratory testing are summarized on the Record of Borehole sheets in Appendix A and also presented on the figures included in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil stratigraphy are presented on these sheets and on the "Borehole Locations and Soil Strata" drawings in Appendix C. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions.

A total of twenty seven boreholes were drilled to date at the locations of the culverts. In general, the subsurface stratigraphy at the location of the culverts consists of topsoil, a surficial layer of silty clay mixed with organics overlying silty clay. The silty clay is generally firm to very stiff within the upper 4 to 6 m, becoming firm to soft with depth until borehole termination. Boreholes drilled at the Highway 400 or Line 5 platforms revealed surficial asphalt and granular fill overlying silty clay. The groundwater level within the cohesive deposits is typically at or within 2 m depth below existing ground surface.

5.1 Topsoil

Topsoil was encountered surficially in boreholes drilled near the locations of Culverts 3, 4, 18 and 28. In Boreholes C4-02, 13-24, 13-25 and 14-16 the topsoil ranged between 25 and 150 mm in thickness. In Boreholes 14-49, 14-41, 14-15, 14-17 and 14-51, the topsoil ranged between 600 and 800 mm in thickness.

The topsoil thickness may vary between and beyond the borehole locations, and the limited data presented in this report should not be used for quantity estimation purposes.

5.2 Asphalt

Pavement structure consisting of asphalt overlying granular fill materials (road base) was encountered in Boreholes 14-36, 14-37, 14-39 and 14-40 drilled for Culverts 1, 3, 15 and 18. These boreholes were drilled on the Highway 400 and Line 5 platforms. The thickness of the asphalt ranged from 13 to 200 mm.

5.3 Fill

A layer of brown sand fill containing some gravel, some silt and trace clay was contacted below the asphalt at the location of Culverts 1, 3, 15, and 18 in Boreholes 14-39, 14-36, 14-37 and 14-40. The thickness of the sand fill ranged from 1.2 m to 1.4 m. The base of fill varied between Elevations 225.3 and 224.1 m.

Boreholes 13-24 and 13-25 drilled near Culvert 4 revealed a layer of brown silty clay/clayey silt fill with sand below the topsoil. The cohesive fill contained trace sand and occasional rootlets. The thickness of the silty clay/clayey silt fill with sand ranged from 0.6 to 3.0 m. The base of fill varied between Elevations 222.6 and 221.1 m.

A 1.5-m thick layer of brown silty clay fill was encountered below the sand fill in Borehole 14-40 (Culvert 18). The base of this fill was at Elevation 223.2 m.

SPT 'N' values in the sand fill ranged from 8 to 27 blows per 0.3 m of penetration, indicating a loose to compact state. An SPT 'N' value of 32 blows per 0.3 m of penetration, indicating a dense condition, was measured in Borehole 14-36. SPT 'N' values recorded in the silty clay/clayey silt fill ranged from 8 to 20 blows per 0.3 m penetration indicating a stiff to very stiff consistency.

Measured moisture contents in the sand fill ranged from 3% to 11%. Measured moisture contents of samples of the silty clay/clayey silt fill varied from 14% to 26%.

Samples of sand fill and silty clay/clayey silt fill were subjected to gradation analysis. Grain size distribution results from these tests are presented on the Record of Borehole sheets and on Figures B1 and B2 in Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Sand Fill Percentage (%)	Silty Clay/Clayey Silt Fill Percentage (%)
Gravel	11	0 to 9
Sand	67 to 81	12 to 38
Silt	14	34 to 53
Clay	8	19 to 40
Silt & Clay	8	-

5.4 Silty Clay with organics

A layer of dark brown silty clay generally mixed with organics or containing occasional organics was contacted surficially at the location of Culverts 4, 16, 17, 23, 25 and 29 in Boreholes C4-01, C16-01, C16-02, C17-01, C17-02, C23-01, C25-01, C25-02 and C29-01. The silty clay layer with organics also contains trace to some sand, roots and rootlets.

The thickness of the silty clay with organics typically ranged from 0.5 to 0.9 m. Locally in Boreholes C4-01 and 17-02, the thickness of this deposit was 1.5 and 2.2 m, respectively. The base of the silty clay with organics ranged between Elevations 220.4 and 227.2m.

SPT 'N' values of the silty clay with organics ranged from 4 to 7 blows per 0.3 m of penetration, indicating a firm consistency. The moisture contents generally ranged from 19% to 28%. A moisture content of 35% was measured in Borehole 25-02.

A sample of the silty clay with organics was subjected to gradation analysis. A grain size distribution curve for the sample of silty clay with orgaincs is presented on the Record of Borehole sheets and on Figure B3 in Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Silty clay w/organics Percentage (%)
Gravel	0
Sand	9
Silt	66
Clay	25

5.5 Sands and Silts

Layers of sand, silt, sandy silt to silty sand containing trace gravel and clay were contacted below the topsoil in Boreholes 14-15, 14-17 and 14-51 at depths of 0.6 to 0.7 m, and interbedded with the silty clay in Boreholes C29-01 and 14-07 at 1.6 m depth. The combined thickness of the sands and silts ranged from 0.7 to 1.7 m. The depth to the base of these cohesionless soils ranged from 1.4 to 3.1 m (Elevations 219.0 to 220.8 m).

SPT 'N' values recorded in these layers ranged from 2 to 15 blows for 0.3 m penetration indicating very loose to compact conditions. Measured moisture contents of samples of the sands and silts ranged between 18% and 21%.

A sample of the sand and silt layer was subjected to gradation analysis. The results of the test are summarized in the table below as well as on the Record of Borehole sheets

included in Appendix B. Figure B4 in Appendix B presents the grain size distribution curve for this sample.

Soil Particles	Sand/Silt
Gravel	0
Sand	41
Silt	39
Clay	20

5.6 Silty Clay

An extensive deposit of native, brown to grey silty clay containing trace to some sand, and occasionally with sand, trace gravel was typically encountered below topsoil, fill, silty clay mixed with organics and cohesionless sands and silts. Occasional organics and wood fibres were noted below 2 m depth in Borehole 14-39.

The sand content within the silty clay was higher, becoming sandy to with sand, in Boreholes C7-01 and C7-02 near Elevations 225.0 and 227.4 m, respectively, and in Borehole C17-01 near Elevation 218.0 m. Occasional cobbles were inferred at approximate Elevation 225 m in Boreholes C7-01 and C7-02. A 0.8 m thick layer of very loose sand was contacted within the silty clay in Borehole C29-01 at 2.3 m depth. Borehole sampling was terminated within the silty clay at depths ranging from 5.2 to 21.2 m (Elevations 202.1 to 223.1 m).

Within the silty clay, a weathered crust in the order of 3 to 5 m thick, transitioning to a lightly over-consolidated zone of between 4 and 10 m thick, was encountered in most of the boreholes. In Boreholes 14-07, 13-24 and 13-25 the crust was apparently thicker and measured up to about 7 m. The silty clay generally becomes stiff to very stiff with depth below the lightly over-consolidated zone.

Within the weathered crust, SPT ‘N’ values recorded in the silty clay typically ranged from 8 to 26 blows per 0.3 m of penetration indicating a stiff to very stiff consistency. SPT ‘N’ values of between 3 and 5 blows per 0.3 m of penetration was measured in Boreholes C29-01 and 14-07 indicating the presence of soft to firm zones. Field vane shear strengths measured in the crust ranged from 55 to 90 kPa.

In the underlying lightly over-consolidated zone, the SPT ‘N’ values generally varied from 4 to 9 blows per 0.3 m of penetration. In conjunction with field vane shear values generally ranging between 25 and 50 kPa, this zone has a typially firm consistency. Occasional values up to 80 kPa indicate the presence of stiff layers. A field vane shear value of 100kPa was measured in Borehole 14-41 near Elevation 217 m. In Borehole 14-15, an SPT ‘N’

value of 1 blow per 0.3 m penetration with corresponding field vane shear strength values of 20kPa indicated the presence of a soft to very soft zone near approximate Elevations 212 to 213.5 m.

The measured moisture content of samples of the silty clay ranged from 9% to 40%. A moisture content of 47% was measured at depth in Borehole 14-50.

Samples of silty clay were subjected to gradation analysis and Atterberg Limits testing. Grain size distribution curves for samples of silty clay tested are presented on the Record of Borehole sheets and on Figures B5 to B13 in Appendix B. Atterberg Limit test results are presented on Figures B14 to B18 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0 to 15
Sand	0 to 40
Silt	26 to 73
Clay	19 to 49
Silt & Clay	66

Soil Particles	Percentage (%)
Liquid Limit	18 to 39
Plasticity Index	11 to 24

The results indicate that the silty clay typically has low plasticity (CL). Two samples of the silty clay from Borehole C7-01, one sample from Borehole C25-01, two samples from Borehole 13-24 and one sample from Borehole 13-25 showed medium plasticity (CI). One sample from Borehole 14-40 is in the group CL-ML.

5.7 Groundwater Levels

Water levels were observed in the open boreholes upon completion of drilling operations. Standpipe piezometers were installed in selected boreholes to monitor water levels after completion of drilling. The water levels measured in the piezometers along with the measurements recorded in the open boreholes upon completion of drilling are summarized in Table 5.2.

Table 5.2 – Water Level Measurements

Culvert	Borehole Number	Date	Water Levels		Comment
			Depth (m)	Elevation (m)	
1	14-39	November 25, 2014	2.7	223.9	Open borehole
3	14-36	December 8, 2014	1.7	224.1	Piezometer
	14-49	November 13, 2014	2.9	218.3	Open borehole
	14-50	December 8, 2014 January 6, 2015	1.6 1.2	221.9 222.3	Piezometer
4	C4-01	May 18, 2015	1.2	220.7	Open borehole
	C4-02	June 3, 2015	0.8	223.6	Piezometer
	13-24	February 26, 2014	2.5	220.9	Piezometer
	13-25	February 26, 2014	2.5	221.7	Piezometer
7	C7-02	June 3, 2015	1.1	230.8	Piezometer
15	14-37	November 17, 2014	1.7	223.6	Open borehole
16	C16-01	June 3, 2015	5.6	218.5	Piezometer
17	C17-01	May 20, 2015	2.0	224.2	Open borehole
	C17-02	June 3, 2015	1.2	225.4	Piezometer
18	14-40	January 14, 2014	8.1	218.1	Open borehole
	14-41	December 8, 2014 January 6, 2015	0.5 0.8	223.7 223.4	Piezometer
23	C23-01	May 21, 2015	3.9	221.4	Open borehole
25	C25-01	May 21, 2015	2.4	225.7	Open borehole
	C25-02	June 3, 2015	0.3	227.2	Piezometer
28	14-15	October 30, 2014	1.9	220.3	Open borehole
	14-16	November 7, 2014 December 8, 2014 January 6, 2015	1.6 1.4 2.0	219.6 219.8 219.2	Piezometer
	14-17	November 7, 2014 December 8, 2014 January 6, 2015	1.9 1.7 1.7	219.6 219.8 219.8	Piezometer
	14-51	October 24, 2014	1.7	219.8	Open borehole
29	C29-01	June 3, 2015	2.0	220.8	Piezometer
	C29-02	June 18, 2015	1.1	222.5	Open borehole

In general, piezometric readings indicate that the water level ranged from 0.3 to 2.5 m below ground surface, except in Borehole C16-01 where the water level was measured at 5.6 m depth. The elevations of the piezometric readings varied from 218.5 to 230.8 m. In Boreholes 14-41 and 25-02, it is noted that the piezometric readings were measured at shallower depths ranging from 0.3 to 0.8 m below ground surface (Elevations 223.4 to 227.2 m).

All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

6 MISCELLANEOUS

Borehole locations were laid out in the field based on information provided by AECOM The ground surface elevation and coordinates at all as-drilled borehole locations were established by Thurber upon completion of drilling. Underground utility clearances were obtained for the borehole locations prior to drilling.

Walker Drilling Inc. of Utopia, Ontario supplied track-mounted and truck-mounted drill rigs, as well as a portable rig mounted on a tripod, and conducted the drilling, sampling and in-situ testing operations.

The field investigation was supervised by Mr. George Azzopardi, C.E.T. and Ms. Eckie Siu of Thurber. Geotechnical laboratory testing was carried out in Thurber's Toronto Area laboratory.

Planning and co-ordination of the field program was conducted by Mr. Lukasz Gilarski, P.Eng. and Mr. Stephane Loranger, C.E.T of Thurber. Overall direction of the program was provided by Mr. Sydney Pang, P.Eng. Interpretation of the data and preparation of this report was carried out by Mr. Sydney Pang, P.Eng. and Ms. R. Palomeque Reyna, P.Eng.

The report was reviewed by Mr. P.K. Chatterji, P.Eng., who is a Designated Principal Contact for MTO Foundations Projects.

THURBER ENGINEERING LTD.

Rocío Palomeque Reyna, P.Eng.
Geotechnical Engineer

Sydney Pang, P.Eng.
Associate, Senior Foundations Engineer

P. K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 INTRODUCTION

This report provides an interpretation of the geotechnical data in the factual report, and presents foundation design recommendations to assist the design team to select and design suitable foundations for the new culverts within the area of the proposed reconstruction of Highway 400 and Line 5 interchange, located in the Town of Bradford West Gwillimbury, Ontario.

Design details of the proposed culverts, as provided by AECOM, are presented in Table 7.1. The approximate heights of fill to be placed above the culverts are also included.

Table 7.1 – Proposed Culvert Details

Culvert	Location	Culvert Type	Culvert Size (mm)	Inlet Invert Elevation (m)	Outlet Invert Elevation (m)	Length (m)	Approx. fill height above culvert (m)
1	Hwy 400 Ramp W-S Sta. 13+120	Conc Box or Open Footing	2400 (Span) x 1200 (Rise)	223.750	223.420	57.69	≈ 2
3	Line 5 Sta. 9+280	CSP Circular	750	219.950	219.850	26.53	≈ 2
4	Line 5 Sta. 9+795	Conc Circular	600	223.500	221.600	75.30	7.0
7	Line 5 Sta. 10+740	Conc Circular	1050	230.600	230.040	37.86	1.3
15	Ramp W-S, Sta. 10+450	Conc Box	Twin 1830 (Span) x 1220 (Rise)	223.170	222.880	34.19	2.6
16	Ramp E-N Sta. 10+375	Conc Circular	600	222.560	222.515	33.82	1.0
17	Ramp W-N Sta. 10+230	Conc Circular	600	224.070	223.960	26.90	1.2
18	Ramp S-EW Station 10+080	Conc Box	2400 (Span) x 1200(Rise)	223.990	223.954	29.74	2.1
23	Coffey Road Sta. 10+936	Conc Box	2400 (Span) x 1200 (Rise)	224.100	224.010	23.11	1.1
25	Coffey Road Sta. 10+460	Conc Circular	1200	226.630	226.500	21.00	1.6
28	Ramp N-EW Sta. 10+490	Conc Box	6000 (Span) x 3000 (Rise)	221.512	220.991	82.57	8.2
29	Line 5 Sta. 9+280	Conc Box	6000 (Span) x 3000 (Rise)	221.220	221.000	52.63	3.4

Culvert 4 is to be located under the Line 5 west approach and Culvert 28 is to be located at the northwest quadrant of the Highway 400 and Line 5 interchange under high fills of the proposed Ramp N-EW and Ramp E-S. The placement of approximately 7.0 to 8.2 m of fill for the new ramps will induce time-dependent ground settlement as a result of consolidation of the underlying silty clay deposit. Foundation comments and recommendations for high fills (embankment design, and construction, settlement and slope stability) have been provided in the following report prepared by Thurber.

- Foundation Investigation and Design Report, New Bridge over North Schomberg River, Fill Embankments and Sucker Creek Culvert, Highway 400 and Line 5 Interchange Reconstruction, Bradford West Gwillimbury, Ontario, TBWG WP P13-03, MTO GWP 2122-10-00 prepared for AECOM dated June 2015 (Reference 1).

Foundation comments and recommendations for Culverts 4 and 28, as well as for other culverts, are presented in Sections 8.5 and 8.6 of this report.

The discussions and recommendations presented in this report are based on the factual data obtained during the course of the investigation. The plans and profiles used for preparation of this report were provided by AECOM.

8 CULVERT FOUNDATIONS

A general description of the subsurface stratigraphy and groundwater condition for each culvert is presented below.

Culverts 1, 15, 18, 23

Concrete box and open footing sections are being considered for use as extensions to Culvert 1. In addition to a short extension on the west side of Culvert 1, Culverts 15, 18 and 23 will cross under the new Ramp W-S, Ramp S-W and the realigned Coffey Road, respectively.

The subsurface stratigraphy near the location of Culvert 1 (Borehole 14-39) extension consists of asphalt and 1.2 m of pavement granular overlying very stiff to firm native silty clay. The groundwater level at the time of investigation was at 2.7 m depth below existing ground surface (Elevation 223.9 m).

The subsurface stratigraphy near the location of Culvert 15 (Borehole 14-37) consists of asphalt and 1.2 m of pavement granular overlying stiff to firm silty clay. The groundwater level was at 1.7m depth below ground surface (Elevation 223.6 m) at the time of the investigation.

The subsurface stratigraphy near the location of Culvert 18 (Borehole 14-40) consists of asphalt and 1.5 m of pavement granular overlying a 1.5 m stiff silty clay fill, which is underlain by native stiff to firm silty clay. In Borehole 14-41, the stratigraphy consists of 0.8 m of topsoil overlying stiff silty clay. The groundwater level measured in the piezometer was at 0.8 m depth below ground surface (Elevation 223.4 m) at the time of the investigation.

The subsurface stratigraphy near the location of Culvert 23 (Borehole 23-01) consists of a surficial 600 mm thick layer of firm silty clay with roots, overlying firm to very stiff silty clay. The groundwater level was at 3.9 m depth below ground surface (Elevation 221.4 m) at the time of the investigation.

Culvert 3 (Boreholes 14-36, 14-49 and 14-50)

Culvert 3 will be located near the proposed Line 5 and Sideroad 5 intersection, approximately 700m west of Highway 400.

The subsurface stratigraphy consists of surficial topsoil up to 0.7 m thick or pavement structure, and dense sand fill overlying very stiff to firm silty clay. The upper weathered crust is typically stiff to very stiff becoming generally stiff to firm with depth. The groundwater level in the piezometers generally ranged from 1.2 to 1.7 m depths below existing ground surface (Elevations 221.9 to 224.1 m).

Culvert 4 (Boreholes C4-01, C4-02, 13-24 and 13-25)

Culvert 4 is to cross perpendicularly under Line 5 below the proposed high fills of the realigned Line 5.

The subsurface stratigraphy at the location of the new concrete circular culvert consists of surficial topsoil and silty clay with organics, ranging in thickness from 50 mm to 1.5 m, overlying silty clay/clayey silt fill and native stiff to firm silty clay. The existing silty clay/clayey silt road embankment fill is 0.8 to 3.0 m thick. The groundwater level generally ranged from 0.8 to 2.5 m depths below ground surface (Elevations 220.9 to 223.6 m).

New fill up to 7.0 m in height will be placed above Culvert 4. The compressible silty clay at the culvert alignment would be subjected to additional vertical pressures resulting in ground settlements. If the culvert is constructed before the fill is placed, the culvert will be subjected to similar magnitudes of settlement. Comments and recommendations regarding settlement of the culvert are provided in Section 8.5.

Culvert 7 (Borehole C7-02)

The subsurface stratigraphy near this location consists of firm to stiff silty clay. The groundwater level was at 1.1 m depth below ground surface (Elevation 230.8 m) at the time of the investigation.

Culvert 16 (Borehole C16-01)

The subsurface stratigraphy at this location consists of a surficial layer of silty clay mixed with organics overlying very stiff to firm silty clay. The layer containing orgaincs is 500 mm thick. A groundwater level measured in the piezometer was at 5.6 m depth below ground surface (Elevation 218.5 m) at the time of the investigation. Based on groundwater levels elsewhere across the interchange site, it is anticipated that the stabilized groundwater level could be within 1 to 2 m depth below ground surface.

Culvert 17 (Boreholes C17-01, C17-02)

The subsurface stratigraphy at this location consists of a surficial layer of silty clay mixed with organics overlying stiff to firm silty clay. The layer of silty clay with organics ranged from 0.8 to

2.2 m in thickness. The groundwater level measured in the piezometer was at 1.2 m depth below ground surface (Elevation 225.4 m) at the time of the investigation.

Culvert 25 (Boreholes C25-01, C25-02)

The subsurface stratigraphy at this location consists of a surficial layer of silty clay mixed with organics, ranging in thickness from 0.5 to 0.9 m, overlying stiff to firm silty clay. The groundwater level was at 0.3 m depth below ground surface (Elevation 227.2 m) at the time of the investigation.

Culvert 28 (Boreholes 14-15, 14-16, 14-17, 14-51)

Culvert 28 is proposed to be used as relief to stormwater surge at the highway interchange areas.

The subsurface stratigraphy at the location of this new concrete box culvert consists of surficial topsoil ranging in thickness from 25 to 700 mm, overlying native loose to compact sand and silt of about 0.7 to 1.7 m in thickness. Very stiff to firm silty clay with occasional soft to very soft zones underlies the sands and silts. The groundwater level varied between 1.7 and 2.0 m depths below ground surface (Elevations 219.2 to 219.8 m).

New fill up to 8.2 m in height will be placed above Culvert 28 for construction of the new Ramps N-EW and E-S. The compressible silty clay at the culvert alignment would be subjected to the imposed embankment loading resulting in foundation settlements. If Culvert 28 is constructed before the fill is placed, the culvert would be subjected to similar magnitudes of settlement. Comments and recommendations regarding settlement of the culvert are provided in Section 8.5.

Culvert 29 (Boreholes C29-01, C29-02)

A new concrete box culvert is proposed for Culvert 29. At this location, the subsurface conditions consist of a surficial layer of silty clay mixed with organics, approximately 0.5 to 0.6 m thick, overlying an upper layer of firm to occasionally soft silty clay. A 0.8 m thick layer of very loose sand was contacted immediately below the upper silty clay at Borehole C29-01. Stiff to very stiff silty clay underlies the site. The groundwater level measured in the piezometer was at 2.0 m below ground surface (Elevation 220.8 m).

New embankment fill up to 3.4 m in height will be placed above Culvert 29, in order to construct the new Ramp N-EW. Some foundation settlement will occur under the new fill.

8.1 Foundation Alternatives

Foundation design issues for culverts are subgrade conditions, bearing resistances, settlement of foundation soils under the weight of the new roadway embankment fill, and stability of the new embankments adjacent to the culverts.

Initially, the following types of culvert have been considered:

- Concrete box (closed) culvert

- Concrete frame (open footing) culvert
- Circular pipes (concrete, steel and HDPE).

A comparison of the technical advantages and disadvantages of different foundation schemes for the culverts is presented in Appendix D.

At locations where culvert extension or replacement are required, consideration may be given to using the same culvert types as the existing culverts. Other options may be considered as discussed below.

Concrete open footing culverts is a technically feasible alternative. However, the compressible silty clay subgrade will provide relatively low geotechnical resistances rendering it difficult for strip footings of typical width to support the required loads at some locations. There is also the potential for post construction settlement. Information provided by AECOM indicates that concrete open footing culverts are currently considered as an option for extensions to Culvert 1.

From a foundation engineering standpoint, concrete, steel and HDPE pipes are technically feasible alternatives provided that other design issues including flow capacity, hydraulic properties and durability can be satisfied.

Given the subsurface conditions and the anticipated construction sequencing, precast concrete box culvert is the preferred culvert replacement option, where feasible, from a foundation engineering standpoint.

Both precast and cast-in place culvert options may be considered. From a foundation engineering perspective, it is preferable to use precast concrete sections rather than cast-in-place construction for the culverts, since the precast units can be installed expeditiously and with less potential for disturbance of the founding soils. Given that there have been concerns about the performance of precast units and, in particular, the issue of leakage at the joints, the relative cost effectiveness between these options should be evaluated.

The culverts must be designed to resist external loadings including frost forces, lateral earth pressures, hydrostatic pressure including uplift, weight of embankment fill, traffic loading and surcharge due to construction equipment.

8.2 Concrete Box (Closed) Culvert

Concrete box culverts are being considered as an option for Culverts 1, 15, 18, 23, 28 and 29.

Based on the borehole data and proposed invert elevations, the recommended highest founding elevations for the box based on design invert elevations and associated sub-

excavation requirements from a foundation engineering perspective are presented in Table 8.1.

Table 8.1 – Founding Levels and Subgrade Preparation for Concrete Box Culvert

Culvert	Reference Borehole	Approx. depth below ground surface (m)	Highest Founding Elevation (m)	Existing Subgrade Soil Type	Sub-excavation Requirements **
1	14-39	3.6*	223.0	Firm silty clay with organics	Sub-excavate to Elev. 222.0 m to native stiff silty clay and backfill
15	14-37	3.1	222.2	Stiff silty clay	See below
18	14-40	2.8*	223.4	Firm to stiff silty clay	Sub-excavate to Elev. 223.2 m to native silty clay and backfill
	14-41	0.8			
23	C23-01	1.8	223.5	Very stiff to stiff silty clay	See below
28	14-15	1.4	220.8	Firm to stiff silty clay or compact sand	Sub-excavate to Elev. 220.0 m to native silty clay or compact sand, and backfill
	14-16	0.4			
	14-17	0.7			
	14-51	0.7			
29	C29-01	1.8	221.0	Stiff silty clay or compact sand	Sub-excavate to Elev. 220.0 m to native silty clay or compact sand, and backfill
	14-07	0.6			

* Below highway grade

** See text below for detailed subgrade preparation requirements.

Following excavation to the design founding levels of the culverts, the Contractor's QVE must verify that the bearing surfaces for the foundation have been prepared on undisturbed, native soils and that bearing surfaces are free of topsoil, organics, fill or other deleterious materials within the culvert footprint. It is important to note that a number of boreholes located near the culverts encountered topsoil, silty clay mixed with organics or fill with organic inclusions. The presence of alluvial and organic deposits should also be expected in the vicinities of the watercourses. The topsoil, organic soils, fill and soft areas must be removed/sub-excavated and replaced with well compacted granular fill. Any fill placed below the culvert to re-establish the founding level should consist of compacted Granular A or Granular B Type II material.

In order to provide a more uniform foundation subgrade condition, a minimum 300 mm thick layer of bedding material conforming to OPSS 1010 Granular A requirements should be provided under the base of the box culverts as per OPSD 803.010. The bedding material should be placed on the approved subgrade as soon as practicable for protecting the subgrade from disturbance during construction following its inspection and approval. Construction equipment must not be allowed to travel on the bedding or the prepared subgrade.

At locations with new fill less than 4 m in height, culverts including Culvert 29 founded on the native, undisturbed stiff to very stiff silty clay, or compact sand, at or below the levels indicated in Table 8.1 on reinstated subgrade level using compacted granular materials, should be designed using concentric, vertical geotechnical resistances provided below:

- Factored Geotechnical Resistance at ULS of 225 kPa
- Geotechnical Resistance at SLS (less than 25 mm settlement) of 150 kPa.

At Culvert 28 where the fill is up to 8.2 m in height with similar subsurface conditions, the following concentric, vertical geotechnical resistances may be used for design:

- Factored Geotechnical Resistance at ULS of 340 kPa
- Geotechnical Resistance at SLS (less than 25 mm settlement) of 260 kPa.

Resistance to lateral forces / sliding resistance between the concrete and the underlying Granular A should be evaluated in accordance with the CHBDC (2010) assuming an ultimate coefficient of friction of 0.4.

8.3 Concrete Frame (Open Footing) Culvert

Based on the borehole data and proposed invert elevations, the highest recommended founding levels for the strip footings of the proposed Culvert 1 extensions are presented in Table 8.2.

Table 8.2 – Highest Recommended Founding Levels for Strip Footings

Culvert Extensions	Reference Borehole	Approx. depth below ground surface at borehole locations (m)	Elevation (m)	Founding Soil Type
1, 15	14-37, 14-39	2.3	223.0	Firm to stiff Silty Clay
18, 23	14-40, C23-01	1.2	223.0	Firm to very stiff Silty Clay

The geotechnical resistances presented in Table 8.3 below are recommended for design of strip footings founded on the native firm to stiff silty clay recommended in Table 8.2 above. The footing width shown in Table 8.3 are an assumed value for typical concrete open frame culverts. The footing width must be designed based on loading requirements from the culvert structure and the overlying embankment fill. The geotechnical resistances will need to be reviewed if the design footing width is different from what is shown in the table below.

Table 8.3 – Geotechnical Resistances for Strip Footings

Culvert	Factored Geotechnical Resistance At ULS (kPa)	Geotechnical Resistance at SLS (kPa)	Assumed Footing Width (m)
1, 15, 18, 23	160	120	1.0

The above values are for vertical, concentric loads only. In the case of eccentric or inclined loading, the geotechnical resistance must be calculated as illustrated in the CHDBC 2010 Clauses 6.7.3 and 6.7.4.

The geotechnical resistances at SLS were computed on the basis of limiting the settlement of an individual culvert footing up to 25 mm under the applied load.

The sliding resistance of concrete placed on native, undisturbed silty clay may be computed on the basis of an ultimate coefficient of friction of 0.35. These are "ultimate" values and require a degree of sliding movement to occur to fully mobilize the resistance.

Subgrade preparation, inspection and approval requirements are similar to those recommenced for box culverts in Section 8.2.

8.4 Circular pipes (concrete, steel and HDPE)

Circular pipes proposed for Culverts 3, 4, 7, 16, 17 and 25.

Subgrade preparation, bedding, backfill and compaction requirements for concrete box culvert presented in Section 8.2 should be followed for circular pipes. OPSD 803.030 or OPSD 803.031 should be referenced for circular pipes.

8.5 Cast-in-place and Precast Culvert Options

The foundation recommendations provided in the preceeding sections for the various culvert types apply to both cast-in-place and precast culvert options.

The designers may select cast-in-place or precast culverts on the basis of a number of considerations including the required extent of excavation, site disturbance, duration of construction, structural performance and cost effectiveness. As discussed previously and

from a foundation engineering perspective, precast units are preferred over cast-in-place units since the former can be installed expeditiously and with minimal disturbance to the founding subgrade, thus reducing the risk of having to sub-excavate and replace disturbed subgrade soils. Concerns regarding joint leakage associated with precast units are acknowledged. It is recommended that the relative cost effectiveness between the two options be evaluated.

The latest available GA drawings for Culverts 4 and 28 indicate that the cast-in-place option has been selected for both locations.

8.6 Culvert Settlement

Fills ranging from low to high are proposed at the culvert locations. High fills of 7.0 m and 8.2 m in height will be placed above Culverts 4 and 28, respectively, for the construction of Ramps N-EW and E-S. At the remaining culverts, the new fill is generally less than 3 m in height and 3.4 m locally at Culvert 29.

The new fills will induce immediate (elastic) settlement in the sand/silt layers and re-compression in the silty clay. Under the high fills, time dependent (consolidation) settlement in the underlying silty clay will occur after fill placement. Settlement of Culverts 4 and 28 are expected to be governed primarily by the settlement of the subgrade (compression of the foundation soils) under the weight of the new fill for Ramps N-EW and E-S.

Settlement analysis involved computation of the immediate and re-compression (elastic) settlement of the foundation soils under the imposed embankment loading, and estimation of long-term consolidation settlement using Terzaghi's one-dimensional consolidation theory.

The estimated subgrade settlements due to the embankment loads at the high fill locations are presented in Table 8.3.

Table 8.3 – Culvert Foundation Settlements

Culvert	Maximum Embankment Height (m)	Elastic Foundation Settlement (mm)	Consolidation Settlement (mm)	Total Settlement (mm)
4	7.0	5	50	55
28	8.2	10	80	90

The total foundation settlements at Culverts 1, 3, 7, 15 to 18, 23, 25, 28 and 29, where the proposed new fills are not more than 3.4 m in height, are anticipated not to exceed 25 mm.

Embankment overbuilding, thus longer culvert, requirements have been provided in the report on fill embankments (Reference 1).

8.6.1 Settlement at Culverts 4 and 28

The compressible silty clay in the vicinity of the culvert alignments would undergo consolidation settlements due to placement of new fill for construction of Ramps N-EW and E-S.

It is understood that the new fill is to be placed to its design height, wait for 6 months or time to be established by the settlement monitoring program, remove the fill at the culvert locations and construct the culverts at their respective alignments prior to backfilling the excavations with compacted material consistent with the remainder of the ramps. Culverts constructed under such conditions will be subjected to estimated post–construction settlement not more than 25 mm.

If culverts are installed before the new fill is placed, consideration should be given to incorporating a camber along the culvert alignments to accommodate the anticipated settlements. Should this be the case, an estimated settlement profile will be provided for detailed camber design. Since this is not the adopted option, further recommendations are not being developed at this time.

Should a proprietary product be selected for these culverts, the proprietary manufacturer/supplier will need to be consulted to determine if their product can sustain the estimated magnitude of settlement.

8.7 Embankment Stability

Stability of the high fills for Ramp N-E/W and Ramp E-S have been addressed in another report (Reference 1). Based on those results, these embankments will satify global stability requirements provided the foundation design and construction recommendations are implemented.

No stability issues are anticipated for the remaining culverts, where the new fill is lower than 3 m in height and 3.4 m locally at Culvert 29.

8.8 Frost Depth

A frost protection soil cover of 1.4 m, or equivalent thickness of insulation, should be used to provide protection against frost action on the culvert base and foundations.

9 CULVERT BACKFILL AND LATERAL EARTH PRESSURES

It is recommended that backfill to the culverts and any wing walls consists of free-draining, non-frost susceptible granular materials such as Granular A or Granular B Type II conforming to the requirements of OPSS.PROV 1010. Reference should be made to the backfill arrangements stipulated in OPSD 803.01, 802.010, 802..030 and 802.031, as appropriate.

All fills must be placed in regular lifts and be compacted in accordance with OPSS.PROV 501. The backfill must be placed and compacted in simultaneous lifts on both sides of a culvert, and the top of backfill elevation should be the same on both sides of the culvert at all times. Heavy compaction equipment must not be used adjacent to the walls and roofs of the culverts.

Earth pressures acting on the culvert walls may be assumed to impose a triangular distribution. For fully drained backfill, the pressures should be computed in accordance with the CHBDC 2010 but are generally given by the expression:

$$p_h = K(\gamma h + q)$$

where p_h = horizontal pressure on the wall at depth h (kPa)
K = earth pressure coefficient (see table below)
γ = bulk unit weight of retained soil (see table below)
h = depth below top of fill where pressure is computed (m)
q = value of any surcharge (kPa)

If full drainage is not achievable, the culvert walls must be designed to withstand full hydrostatic pressure assuming a water level at least equal to the design river or creek water level.

Earth pressure coefficients for backfill to the retaining walls are dependent on the material used as backfill. Recommended unfactored values are shown in the following Table 9.1. Active pressures should be used for any wing wall or unrestrained wall.

For rigid structures such as concrete box culverts, it is recommended that at-rest horizontal earth pressures be used for design.

Table 9.1
Earth Pressure Coefficients (K)

Wall Condition	Earth Pressure Coefficient (K)					
	OPSS Granular A or OPSS Granular B Type II $\phi = 35°; \gamma = 22.8$ kN/m^3		OPSS Granular B Type I (modified) $\phi = 32°; \gamma = 21.2$ kN/m^3		Embankment Fill $\phi = 30°; \gamma = 20.0$ kN/m^3	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (Unrestrained Wall)	0.27	0.40	0.31	0.48	0.33	0.54
At rest (Restrained Wall)	0.43	0.62	0.47	0.70	0.50	0.76

Passive (Movement Towards Soil Mass)	3.7	-	3.3	-	3.0	-

In accordance with Clause 6.9.3 of the CHBDC, a compaction surcharge should be added. The magnitude should be 12 kPa at the top of fill and decreasing to 0 kPa at a depth of 2.0 m for Granular B Type I, or at a depth of 1.7 m for Granular A or Granular B Type II.

10 SCOUR PROTECTION AND EROSION CONTROL

Culverts should be provided with scour protection where required. Erosion control should be provided at the culvert inlet and outlet areas as applicable. Design of the scour and erosion protection measures must consider hydrologic and hydraulic concerns and should be carried out by specialists experienced in this field.

Typically, rock protection should be provided over all surfaces with which creek water is likely to be in contact. Treatment at the outlets should be in accordance with OPSD 810.010. A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion in general accordance with OPSS.PROV 804.

It is recommended that a clay seal or a concrete cut-off wall be used to minimize the potential for piping around the culvert. The clay seal must extend to the order of 0.3 m above the high water level and laterally for the width of the granular material, and have a minimum thickness of 0.5 m. The material requirements should be in accordance with OPSS.PROV 1205. A geo-synthetic clay liner may be used as a clay seal.

11 ROADWAY PROTECTION

Roadway protection may be required during construction of the culverts. An item titled "Protection System" as per OPSS.PROV 539 should be included in the contract documents. It is recommended that Performance Level 2 as per Clause 539.04.01.01 and the alignment of the shoring be specified on the contract drawings.

The design of roadway protection should be the responsibility of the Contractor. However, one option that is considered to be suitable for use as temporary shoring at this site is a soldier pile and lagging wall. It is anticipated that the soldier piles will need to be extended into the stiff to very stiff silty clay below the excavations in order to develop the required toe resistance. It is anticipated that the shoring system may be stiffened by cross bracings, where applicable.

A temporary soldier pile and lagging wall may be designed using the parameters given below:

γ = 20 kN/m^3

γ_w = 10 kN/m^3

K_a	=	0.33 (approach fills)
	=	0.33 (silty clay)
K_p	=	3.0 (approach fills)
	=	3.0 (silty clay)

The designer of the roadway protection system should check whether the depth of pile is sufficient to provide base fixity.

The actual pressure distribution acting on the shoring system is a function of the construction sequence and the relative flexibility of the wall and these factors must be considered when designing the shoring system. All shoring systems should be designed by a Professional Engineer experienced in such designs.

12 EXCAVATION

Temporary excavations will be required at the culvert sites. All temporary excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purpose of OHSA, the native silty clay, sands/silts and existing fills at the site may be classified as Type 3 soils. Exposed sands and silts and soft silty clay below the groundwater level are classified as Type 4 soils.

All excavations must be carried out in a manner that avoids undermining or destabilising the existing structures and road embankments.

13 GROUNDWATER AND SURFACE WATER CONTROL

The water table is high (near ground surface) at all culvert sites. However, the foundation soils are predominantly silty clay which is relatively impermeable. It is anticipated that the amount of perched water within existing fills, where present, would be limited. Groundwater from water-bearing interlayers within the silty clay should also be minimal. However, groundwater flow from surficial sand and silt layers should be expected at some locations. For temporary excavations for culvert installation, groundwater control will likely be limited to diverting surface runoff and preventing precipitation from entering the excavations supplemented by sump pumping. Filtered sumps must be designed properly so that construction drainage water containing eroded soil and fines do not flow onto existing roadways and watercourses.

At the culvert sites, the groundwater level is expected to be largely governed by the water level in the river or creek. In order to facilitate the construction works, unwatering methods including, but not necessarily limited to, temporary diversion of river, creek and other surface water, sandbag and/or sheetpile cofferdams will be required. The Contractor must make provisions to control any water seepage, surface runoff and ponding by measures including the use of sump pumps to maintain dry excavations during the course of the works.

The design of any dewatering system that may be required is the responsibility of the Contractor and the Contract Documents must alert him to this responsibility and the need to engage a dewatering specialist.

14 OVERHEAD SIGN SUPPORT

14.1 General

This section of the report presents foundation recommendations for the design of the proposed tri-chord sign supports. This project includes a total of four (4) sign structures, each with two supports, that are to be located at both the northbound and southbound lanes on Highway 400.

Information on the proposed locations of the signs was provided to Thurber by AECOM. Based on the proposed design layout, subsurface information available from nearby borehole from Geocres and other available boreholes has been used. The relevant Record of Borehole sheets are presented in Appendix A. Table 1 immediately following the text of this report indicates the relevant boreholes that are in the vicinity of the signs and have been used for providing the geotechnical parameters for foundation design.

14.2 Foundation Design Parameters

Design of the sign support foundations should be carried out in accordance with the following document.

- Ministry of Transportation, Ontario (2015) "Sign Support Manual", Highway Standards Branch, Bridge Office (Reference 2)

Reference should also be made to the following documents.

- Ministry of Transportation, Ontario (2004) "Guidelines for the Design of High Mast Pole Foundation", Fourth Edition, BRO-009, Engineering Standards Branch, Bridge Office (Reference 3).
- Canadian Highway Bridge Design Code and Commentary (2010). CAN/CSA-S6-00 and S6.1-00 (Reference 4).

It is understood that a typical tri-chord sign foundation consists of two conventional augered caissons (drilled shafts). Table 1 following the text of this report presents the recommended foundation design parameters for the design of such caissons. Table 1 also contains recommended design groundwater levels based on water level observations in the relevant boreholes. Should a standard configuration as shown on SS118-3 to 118-5 in Reference 2 be used as a basis for the caisson design, the recommended parameters in

conjunction with the methods in References 2 and 3 should be used to check the validity of the standard design.

In order to take into account frost action and surficial disturbance, the ultimate lateral passive resistance in front of a caisson within the upper 1.2 m below final grade should be neglected in the foundation design. It is recommended that all topsoil and organics be neglected in determining lateral resistance.

Where downward sloping fill or native soil exists in front of a caisson, reduction of lateral passive resistance should be taken into account during design. For foundation design at the caissons, it should be assumed that full lateral resistance can only be mobilized where the width of the soil in front of or behind the caisson is equal to or greater than approximately four (4) times the diameter of the caissons. For sloping ground in front of a caisson, the magnitude of the mobilized passive resistance can be estimated by interpolating between zero passive resistance at the level where the slope face intersects the pile, and full passive resistance at the level where the slope face is equal to or greater than four (4) times the diameter of the caisson.

Where an unconfined compressive strength, q_u is provided for a cohesive soil (clayey silt to silty clay fill, silty clay to silty clay till), the ultimate lateral passive resistance should be calculated in conjunction with the total soil unit weight. When designing for portions of the caissons below the groundwater level in cohesionless sands and silts, the submerged soil unit weight, γ' should be used. The required depth of the drilled shaft will be governed by lateral loads, including wind loads, acting on the sign. The length of the caisson should also be sufficient to counteract frost jacking (upward) forces.

An equivalent caisson width equal to 2 times the caisson diameter may be assumed for lateral resistance calculations. Appropriate load and resistance factors should be applied for caisson design.

14.3 Caisson installation

Caisson installation should generally be carried out in accordance with OPSS 903.

The contract documents should contain an NSSP alerting the contract bidders of the specific aspects relating to caisson construction for the tri-chord sign foundation supports. Suggesting wordings for this NSSP are provided in Appendix E.

Caisson installation equipment must be able to dislodge, handle, remove cobbles, to penetrate obstructions within the fills, and to drill through hard or very dense layers, where encountered.

The short term groundwater levels were determined to range from about 2 to 3 m depth below existing ground surface. The stabilized groundwater levels may be higher. Soil sloughing and water seepage may occur in unsupported holes especially in sands and silts below the groundwater level. Temporary liners must be available to support the caisson sidewalls and to provide seepage cut-off where required. Any accumulated water may have to be pumped out from the hole prior to placing concrete. Should it be considered impractical to remove the accumulated water inside the hole, it is recommended that the concrete be placed by the tremie method.

14.4 Construction Considerations

Caisson construction for the sign supports mainly involve the handling and removal of obstructions in the fills, cobbles, drilling through hard or very dense soils, soil sloughing and water seepage from caisson sidewalls, and basal instability. Recommendations on how to address these issues have been outlined in the previous section.

Caisson construction should be monitored by qualified geotechnical personnel, as per OPSS 903, to verify the soil conditions and to confirm that those conditions are consistent with the design assumptions in this report.

15 SEISMIC CONSIDERATIONS

The following seismic parameters should be used for design:

- Velocity Related Seismic Zone 0
- Zonal Velocity Ratio 0.05
- Acceleration Related Seismic Zone 1
- Zonal Acceleration Ratio 0.05
- Peak Horizontal Acceleration 0.05

The soil profile type for this site has been classified as Type I. Therefore, according to Table 4.4.6.1 of the CHBDC, a Site Coefficient “S” (ground motion amplification factor) of 1.0 should be used in seismic design.

Based on the CHBDC, the foundation silty clay at this site is assessed to be not prone to liquefaction.

16 EXISTING AND NEWLY INSTALLED UTILITY SERVICES

It is recommended that the exact locations of any existing and newly installed utilities be established by the designer, and compared with the extent of the potential work zones related to the

construction of the proposed works. These utilities must not be adversely affected during construction of the works.

If necessary, relocation of, and/or special protective measures for affected utilities may be required.

Potential impact of high fill induced foundation settlement on buried utilities has been addressed in Reference 1.

17 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to, the following:

- Daily visual inspection of the pavement surface must be carried out in the vicinity of the culvert replacement and/or extensions below or adjacent to the travelled roadway. If cracks in the pavement or settlement is observed, the observations must immediately be brought to the attention of the C.A. to determine whether remedial action is required at some locations.
- Adequate dewatering of the temporary excavations to install the foundation for the new culverts; river/creek diversion and/or cofferdam may be required.
- Removal of peat, organics, soft soils and alluvial deposits near river and creek channels.
- Care must be exercised during excavation to avoid disturbing the founding subgrade. The exposed subgrade soils should be expeditiously inspected, approved and protected from disturbance.
- The bases of the culvert foundation excavations must be inspected to confirm that the base of the excavation is free from inclusions of organic soils or loose, alluvial deposits and debris.
- Confirmation that the culvert backfills are adequately placed and compacted to specifications.

18 CLOSURE

Engineering analysis and preparation of the report were carried out by Ms. R. Palomeque Reyna, P.Eng and Dr. Sydney Pang, P.Eng.

The report was reviewed by Dr. P. K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

THURBER ENGINEERING LTD.

Rocío Palomeque Reyna, P.Eng.
Geotechnical Engineer

Sydney Pang, P.Eng.,
Associate, Senior Foundations Engineer

Report Reviewed by:
P. K. Chatterji, P.Eng.,
Review Principal, Designated MTO Contact

Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

SS Split Spoon Sample; WS Wash Sample; AS Auger (Grab) Sample
TW Thin Wall Shelby Tube Sample; TP Thin Wall Piston Sample
PH Sampler Advanced by Hydraulic Pressure; PM Sampler Advanced by Manual Pressure
WH Sampler Advanced by Self Static Weight; RC Rock Core; SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

$\blacktriangledown$ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

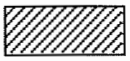
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

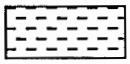
EXPLANATION OF ROCK LOGGING TERMS

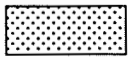
ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS


CLAYSTONE


SILTSTONE


SANDSTONE


COAL


Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

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RECORD OF BOREHOLE No 13-24 1 OF 1 METRIC

W.P. P-13-03 LOCATION High Fill/Ramp N-EW N 4 881 617.8 E 294 596.3 ORIGINATED BY GA

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.01.30 - 2014.01.30 CHECKED BY KY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
223.4	GROUND SURFACE										
0.0	**TOPSOIL:** (150 mm)										
0.2	Clayey **SILT**, with sand, trace gravel, occasional rootlets Stiff Brown Moist (FILL)		1	SS	9		223				9 38 34 19
222.6											
0.8	Silty **CLAY**, trace sand Stiff to Very Stiff Brown Moist		2	SS	8		222				
			3	SS	12						
			4	SS	16	▼	221				
			5	SS	14		220				0 0 41 59
			6	SS	17		219				
			7	SS	13						0 0 54 46
							218				
	Grey Wet		8	SS	13		217				
							216				
	Firm		9	SS	7						
215.2											
8.2	END OF BOREHOLE AT 8.2 m. BOREHOLE OPEN TO 8.2 m AND WATER LEVEL AT 8.2m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Feb 26/ 14 2.5 220.9										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No 13-25 1 OF 2 METRIC

W.P. P-13-03 LOCATION High Fill/Ramp N-EW N 4 881 628.3 E 294 649.5 ORIGINATED BY GA

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.01.29 - 2014.01.29 CHECKED BY KY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
224.2	GROUND SURFACE										
0.0	**TOPSOIL:** (50 mm)						224				
0.0	Silty **CLAY**, with sand, trace gravel Very Stiff to Stiff Brown Moist (FILL)		1	SS	20						
			2	SS	12		223				6 35 36 23
			3	SS	9						
	Occasional rootlets Grey		4	SS	8	▼	222				0 21 53 26
221.1											
3.0	Silty **CLAY**, trace sand, trace gravel Firm to Stiff Grey Moist		5	SS	6		221				
			6	SS	9		220				
219.7											
4.5	Very Stiff		7	SS	20		219				
218.5											
5.6			8	SS	15		218				0 0 46 54
			9	SS	14		217				
			10	SS	12		216				
							215				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No 13-25 2 OF 2 METRIC

W.P. P-13-03 LOCATION High Fill/Ramp N-EW N 4 881 628.3 E 294 649.5 ORIGINATED BY GA

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.01.29 - 2014.01.29 CHECKED BY KY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY** Firm Grey Wet						214				
			11	SS	7				⊕		0 0 44 56
212.9							213				
11.3	END OF BOREHOLE AT 11.3 m. BOREHOLE OPEN TO 10.6 m AND WATER LEVEL AT 7.1 m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Feb 26/ 14 2.5 221.7										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 14-07 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 29/Ramp N-EW N 4 881 857.5 E 294 677.9 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Wash Boring/Tripod COMPILED BY AN

DATUM Geodetic DATE 2014.12.04 - 2014.12.04 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.6	GROUND SURFACE										
0.0 / 221.0	**TOPSOIL**, trace roots and rootlets Loose Dark Brown Moist		1	SS	4		221				
0.6 / 220.1	Silty **CLAY**, some sand, trace gravel Firm Brown Moist		2	SS	5	▽	220				0 25 49 26
1.6 / 219.0	**SAND**, trace gravel Compact to Loose Brown Wet		3	SS	15						
2.6	Silty **CLAY**, trace sand, trace gravel Stiff Grey Moist		4	SS	9		219				
			5	SS	10		218				
	Wet		6	SS	13		217				0 4 48 48
			7	SS	11		216				
			8	SS	9		215				
			9	SS	11		214				
211.9							213				
9.8	END OF BOREHOLE AT 9.8m.						212				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 14-07 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 29/Ramp N-EW N 4 881 857.5 E 294 677.9 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Wash Boring/Tripod COMPILED BY AN

DATUM Geodetic DATE 2014.12.04 - 2014.12.04 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	WATER LEVEL AT 1.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 14-15 1 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 28/Ramp E-S N 4 881 704.9 E 294 627.0 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.10.29 - 2014.10.30 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS
222.2	GROUND SURFACE					
0.0	**TOPSOIL**, trace roots and rootlets, trace sand Loose Dark Brown		1	SS	5	
221.6	Moist					
0.6	**SAND** and **SILT**, some clay Compact Brown Moist		2	SS	11	
220.8						
1.4	Silty **CLAY**, trace sand, trace gravel Stiff Grey Moist		3	SS	10	▽
			4	SS	15	
			5	SS	15	
			6	SS	9	
216.6						
5.6	Soft Wet		7	SS	3	
			8	SS	4	
			9	SS	1	

ELEVATION SCALE: 222, 221, 220, 219, 218, 217, 216, 215, 214, 213

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100

2.3

3.3

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)

	GR	SA	SI	CL
	0	41	39	20
	0	7	52	41
	0	0	65	35

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 + 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 14-15 2 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 28/Ramp E-S N 4 881 704.9 E 294 627.0 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.10.29 - 2014.10.30 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY** Firm to Stiff Grey Wet						212	2.5			
			10	SS	5				○		
							211	3.5			
			11	SS	5		210		○		
							209				
			12	SS	7				○		
							208	3.0			
			13	SS	6		207		○		
							206	4.0			
			14	SS	7				○		
							205	2.5			
							204				
	Trace sand		15	SS	9				⊢○⊣		0 5 49 46
	Some sand, trace gravel Moist						203				
	Sandy		16	SS	50/				○		0 40 26 34
	Continued Next Page										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 14-15 3 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 28/Ramp E-S N 4 881 704.9 E 294 627.0 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.10.29 - 2014.10.30 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
202.1					0.100						
20.1	END OF BOREHOLE AT 20.1m. WATER LEVEL AT 1.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 14-16 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 28/Ramp N-EW N 4 881 695.2 E 294 599.3 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.11.04 - 2014.11.05 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.2	GROUND SURFACE										
0.0	**TOPSOIL:** (25mm)										
0.0	Silty **CLAY**, trace sand, occasional roots, occasional organics Stiff to Firm Brown to Dark Brown Moist		1	SS	8		221				
			2	SS	7		220				
219.8											
1.4	Very Stiff Brown to Grey Moist		3	SS	16		219				
			4	SS	16		218				
			5	SS	17						0 0 55 45
217.1							217				
4.1	Firm to Soft Grey Wet		6	SS	8		216	2.7			
			7	SS	5		215				
							214	2.6			
			8	SS	3		213				
								2.3			
			9	SS	2		212				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No 14-16 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 28/Ramp N-EW N 4 881 695.2 E 294 599.3 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.11.04 - 2014.11.05 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	Silty **CLAY** Soft to Firm Grey Wet						211	3.0			
			10	SS	2						0 0 67 33
							210	2.4			
			11	SS	4		209				
207.9							208	2.6			
13.3	END OF BOREHOLE AT 13.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov 07/ 14 1.6 219.6 Dec 08/ 14 1.4 219.8 Jan 06/ 15 2.0 219.2										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-17 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 28/Ramp E-S N 4 881 714.1 E 294 655.5 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.10.23 - 2014.10.23 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.5	GROUND SURFACE										
0.0 / 221.0	**TOPSOIL**, some sand, occasional roots and rootlets Loose Dark Brown Moist		1	SS	4		221				
0.6 / 220.1	Sandy **SILT**, occasional sand seams Loose Brown Moist		2	SS	7						
1.4 / 219.2	**SAND**, trace silt Compact Brown Wet		3	SS	13	▼	220				
2.3	Silty **CLAY**, trace to some sand Stiff to Very Stiff Grey Moist		4	SS	13		219				0 7 53 40
	Trace gravel		5	SS	19		218				
	Wet		6	SS	9		217				
215.9 / 5.6	Firm		7	SS	7		216				0 0 55 45
214.3 / 7.2	Soft		8	SS	3		215				
212.8 / 8.7			9	SS	6		214				
							213				
							212				

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Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-17 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 28/Ramp E-S N 4 881 714.1 E 294 655.5 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.10.23 - 2014.10.23 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, occasional sand seams Firm Grey Wet						211				
			10	SS	6				○		
							210				
			11	SS	7		209		○		0 8 45 47
208.2								3.6			
13.3	END OF BOREHOLE AT 13.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov 07/ 14 1.9 219.6 Dec 08/ 14 1.7 219.8 Jan 06/ 15 1.7 219.8										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \cdot 10 \cdot 5}$ (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-36 1 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 3, Station 9+300 N 4 881 463.2 E 294 111.3 ORIGINATED BY ES

HWY Line 5 BOREHOLE TYPE Solid Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2014.11.19 - 2014.11.19 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
225.8	GROUND SURFACE										
0.0	**ASPHALT:**(200mm)										
0.2	**SAND**, some gravel, some silt, trace clay Dense Brown Moist (FILL)		1	GS					○		
224.4			1	SS	32		225		○		11 67 14 8
1.4	Silty **CLAY**, trace sand Firm to Stiff Brown Moist		2	SS	7	▼	224		○		
	Trace gravel		3	SS	12		223		○		
			4	SS	14		222		⊖		0 0 51 49
	Grey		5	SS	15		221		○		
	Wet		6	SS	10		220		○		
							219	+ 2.5			
			7	SS	6		218		⊖		0 0 54 46
							217	+ 3.0			
			8	SS	10		216		○		

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-36 2 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 3, Station 9+300 N 4 881 463.2 E 294 111.3 ORIGINATED BY ES

HWY Line 5 BOREHOLE TYPE Solid Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2014.11.19 - 2014.11.19 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, trace sand Firm to Stiff Grey Wet						215	2.2			
			9	SS	5						
							214	2.6			
			10	SS	12						
							213				
							212				
			11	SS	8						0 0 55 45
							211	2.4			
			12	SS	8						
							210				
								2.2			
			13	SS	10		209				
208.4											
17.4	End of sampling and start of DCPT						208				
							207				
							206				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \to 5}$ (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-36 3 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 3, Station 9+300 N 4 881 463.2 E 294 111.3 ORIGINATED BY ES

HWY Line 5 BOREHOLE TYPE Solid Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2014.11.19 - 2014.11.19 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
205.2											
20.6	END OF BOREHOLE AT 20.6m UPON DCPT REFUSAL. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.02m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Dec 08/ 14 1.7 224.1										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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Ontario

THURBER

RECORD OF BOREHOLE No 14-37 1 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 15, Station 10+600 N 4 881 431.9 E 294 790.5 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2014.11.17 - 2014.11.17 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
225.3	GROUND SURFACE										
0.0	**ASPHALT:** (13mm)										
	SAND, trace to some gravel Loose Brown Moist (FILL)		1	GS			225				
224.1			1	SS	8						
1.2	Silty **CLAY**, trace sand, trace gravel Firm Dark Brown to Grey Moist		2	SS	5	▽	224				
			3	SS	5		223				0 9 50 41
	Grey										
222.3											
3.0	Very Stiff to Stiff		4	SS	16		222				
			5	SS	14		221				
							220				
	With sand Wet		6	SS	12		219				0 25 41 34
			7	SS	8		218				
							217				
	Grey		8	SS	8		216				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No 14-37 2 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 15, Station 10+600 N 4 881 431.9 E 294 790.5 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2014.11.17 - 2014.11.17 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, trace sand Firm Grey Wet										
			9	SS	6						0 0 59 41
212.5			10	SS	7						
12.8	End of sampling and start of DCPT										

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No 14-37 3 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 15, Station 10+600 N 4 881 431.9 E 294 790.5 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2014.11.17 - 2014.11.17 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
							205				
204.6											
20.7	END OF BOREHOLE AT 20.7m UPON DCPT REFUSAL. WATER LEVEL IN OPEN BOREHOLE AT 1.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-39 1 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 1, Station 10+600 N 4 881 431.3 E 294 831.9 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.11.25 - 2014.11.25 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
226.6	GROUND SURFACE										
0.0	**ASPHALT:** (90mm)										
0.1	**SAND**, some gravel Compact Brown Moist (FILL)		1	GS			226		○		
225.3			1	SS	16				○		
1.3	Silty **CLAY**, trace sand, trace gravel Very Stiff to Firm Brown Moist		2	SS	26		225		○		
	Occasional wood fibres Brown to Grey		3	SS	9	▽	224		⊖		0 7 57 36
	Occasional organics Grey to Dark Brown		4	SS	6		223		○		
222.5											
4.1	Stiff Brown Moist		5	SS	12		222		○		
	Occasional sand pockets Grey		6	SS	11		221		○		
							220				
	With sand		7	SS	8		219		⊖		3 36 39 22
							218	+ 4.5			
			8	SS	4		217		○		

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 + 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-39 2 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 1, Station 10+600 N 4 881 431.3 E 294 831.9 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.11.25 - 2014.11.25 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, trace sand, trace gravel Firm to Stiff Grey Wet										
			9	SS	6						0 11 42 47
			10	SS	4						
213.8											
12.8	End of sampling and start of DCPT										

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-39 3 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 1, Station 10+600 N 4 881 431.3 E 294 831.9 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.11.25 - 2014.11.25 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
							206				
							205				
204.7											
21.9	END OF BOREHOLE AT 21.9m UPON DCPT REFUSAL. WATER LEVEL IN OPEN BOREHOLE AT 2.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 10 5 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-40 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 18 N 4 881 455.2 E 294 865.6 ORIGINATED BY GA

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.10.15 - 2014.10.16 CHECKED BY KY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
226.2	GROUND SURFACE										
0.0	**ASPHALT:**(75 mm)										
0.1	**SAND**, some gravel, trace silt and clay Compact Brown Moist (FILL)		1	SS	27		226				
			2	SS	24		225				11 81 8 (SI+CL)
224.7											
1.5	Silty **CLAY**, some sand, trace gravel Stiff Brown Moist (FILL)		3	SS	15		224				
			4	SS	14						0 12 48 40
223.2							223				
3.0	Silty **CLAY**, trace sand Firm to Stiff Grey Moist		5	SS	7						
			6	SS	7		222				
			7	SS	10						
							221				
			8	SS	10		220				
							219				
	Some sand, some gravel Grey Wet		9	SS	8	▽					15 18 42 25
							218	+ 3.0			
			10	SS	14		217				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-40 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 18 N 4 881 455.2 E 294 865.6 ORIGINATED BY GA

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.10.15 - 2014.10.16 CHECKED BY KY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, trace to some sand and gravel Stiff Grey Wet						216				
214.9			11	SS	10		215		○		
11.3	END OF BOREHOLE AT 11.3 m. BOREHOLE OPEN TO 11.3 m AND WATER LEVEL IN OPEN BOREHOLE AT 8.1 m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.4 m, CONCRETE TO 0.1 m THEN ASPHALT PATCH TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 10 5 (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-41 1 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 18, Station 10+600 N 4 881 451.9 E 294 904.5 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2014.11.13 - 2014.11.13 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
224.2	GROUND SURFACE										
0.0	**TOPSOIL**, occasional roots Very Loose Dark Brown Wet		1	SS	1		224		○		
223.4	(800mm)										
0.8	Silty **CLAY**, trace sand Stiff Brown to Grey Moist		2	SS	10	▼	223		○		
			3	SS	10		222		○		
	Grey		4	SS	14				○		
			5	SS	13		221		○		
	Wet		6	SS	11		220		○		
			7	SS	8		219		○		
	Moist						218		○		
			8	SS	14		217	+	○		
			9	SS	10		216		○		
							215		○		

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

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Ontario

THURBER

RECORD OF BOREHOLE No 14-41 2 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 18, Station 10+600 N 4 881 451.9 E 294 904.5 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2014.11.13 - 2014.11.13 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60	γ kN/m^3	GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**,trace sand, occasional silt seams Very Stiff to Stiff Grey Wet										
			10	SS	15						
			11	SS	9						
			12	SS	14						
			13	SS	12						
208.4											
15.8	End of sampling and start DCPT										

214 213 212 211 210 209 208 207 206 205

2.5

2.9

○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE

w_P w w_L

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \to 10}$ 5 (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-41 3 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 18, Station 10+600 N 4 881 451.9 E 294 904.5 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2014.11.13 - 2014.11.13 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
							204				
203.0											
21.2	END OF BOREHOLE AT 21.2m UPON DCPT REFUSAL. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Dec 08/ 14 0.5 223.7 Jan 06/ 15 0.8 223.4										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-49 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 3, Station 9+300 N 4 881 481.0 E 294 108.6 ORIGINATED BY ES

HWY Line 5 BOREHOLE TYPE Hollow Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2014.11.13 - 2014.11.13 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.2	GROUND SURFACE										
0.0	**TOPSOIL**, trace clay, occasional roots and rootlets Firm Dark Brown		1	SS	7		221				
220.5	Moist										
0.7	Silty **CLAY**, trace sand Very Stiff to Stiff Brown Moist		2	SS	20		220				
			3	SS	16		219				
			4	SS	9	▽	218				
			5	SS	17		217				
			6	SS	14		216				
215.6							215	2.3 +			
5.6	Firm Grey Wet		7	SS	7		214				
			8	SS	5		213	4.4 +			
212.5							212				
8.7	Stiff		9	SS	4						

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-49 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 3, Station 9+300 N 4 881 481.0 E 294 108.6 ORIGINATED BY ES

HWY Line 5 BOREHOLE TYPE Hollow Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2014.11.13 - 2014.11.13 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS
	Continued From Previous Page					
	Silty **CLAY**, trace sand Firm Grey Wet					
			10	SS	5	
			11	SS	7	
208.4						
12.8	End of sampling and start of DCPT					
203.6						
17.6	END OF BOREHOLE AT 17.6m. WATER LEVEL AT 2.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.					

ELEVATION SCALE: 211, 210, 209, 208, 207, 206, 205, 204

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

3.4
3.5

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%)
20 40 60

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-50 1 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 3, Station 9+300 N 4 881 455.2 E 294 111.7 ORIGINATED BY ES

HWY Line 5 BOREHOLE TYPE Hollow Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2014.11.11 - 2014.11.11 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
223.5	GROUND SURFACE										
0.0	Silty **CLAY**, trace sand, occasional organics, occasional roots Stiff to very Stiff Brown Moist		1	SS	9		223		○		
			2	SS	9	▼	222		○		
			3	SS	8		221		○		
			4	SS	19		220		○		
			5	SS	18		219		○		
	Grey		6	SS	16		218		○		
	Moist		7	SS	9		217	+ 2.3	○		
	Wet		8	SS	8		216		○		
			9	SS	6		215	+ 2.3	○		
							214				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-50 2 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 3, Station 9+300 N 4 881 455.2 E 294 111.7 ORIGINATED BY ES

HWY Line 5 BOREHOLE TYPE Hollow Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2014.11.11 - 2014.11.11 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	WATER CONTENT (%) (PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, trace sand Firm Grey Wet							3.0			
			10	SS	7		213		○		
							212	2.7			
210.7			11	SS	8		211		○		
12.8	End of sampling and start of DCPT						210				
							209				
							208				
							207				
							206				
205.0							205				
18.6	END OF BOREHOLE AT 18.6m UPON DCPT REFUSAL. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Dec 08/ 14 1.6 221.9										

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-50 3 OF 3 METRIC

W.P. P-13-03 LOCATION Culvert 3, Station 9+300 N 4 881 455.2 E 294 111.7 ORIGINATED BY ES

HWY Line 5 BOREHOLE TYPE Hollow Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2014.11.11 - 2014.11.11 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Jan 06/ 15 1.2 222.3										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \cdot 5}$ (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-51 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 28 N 4 881 727.4 E 294 691.7 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.10.24 - 2014.10.24 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.5	GROUND SURFACE										
0.0	**TOPSOIL**, occasional roots and rootlets Loose Dark Brown Moist		1	SS	6						
220.8											
0.7	Silty **SAND**, trace gravel Compact Brown Moist		2	SS	12						
220.1											
1.4	Silty **CLAY**, trace to some sand Firm Grey Moist		3	SS	5	▽					
219.3											
2.2	Very Stiff Trace gravel		4	SS	16						
			5	SS	22						0 4 48 48
217.5											
4.0	Wet		6	SS	8						
			7	SS	4						
			8	SS	4			2.8			0 0 61 39
			9	SS	5			3.2			

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}$ 5 (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 14-51 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 28 N 4 881 727.4 E 294 691.7 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2014.10.24 - 2014.10.24 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY** Stiff Grey Wet						211				
			10	SS	8			2.9			0 4 49 47
							210				
208.9			11	SS	7		209				
12.6	END OF BOREHOLE AT 12.6m. WATER LEVEL AT 1.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C4-01 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 4 N 4 881 669.6 E 294 602.9 ORIGINATED BY ES

HWY Line 5/Hwy 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.28 - 2015.05.28 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.9	GROUND SURFACE										
0.0	Silty **CLAY**, trace sand, occasional organics, roots and rootlets Firm Dark Brown Moist		1	SS	6						
			2	SS	4	▽	221				
220.4											
1.5	Silty **CLAY**, some sand Stiff to Firm Grey Wet		3	SS	13		220				
			4	SS	10		219				
			5	SS	12						0 0 53 47
			6	SS	5		218				
			7	SS	4		217	2.8			
214.7							216				
7.2	Soft		8	SS	3		215	3.5			
			9	SS	1		214	3.0			
							213				
							212				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C4-01 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 4 N 4 881 669.6 E 294 602.9 ORIGINATED BY ES

HWY Line 5/Hwy 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.28 - 2015.05.28 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, trace sand Soft to Firm Grey Wet							5.0			
			10	SS	3		211		○		
								3.5			
							210				
			11	SS	4				○		
208.6							209				
								2.8			
13.3	END OF BOREHOLE AT 13.3m. WATER LEVEL AT 1.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C4-02 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 4 N 4 881 593.6 E 294 623.3 ORIGINATED BY ES

HWY Line 5/Hwy 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.26 - 2015.05.26 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
224.4	GROUND SURFACE										
0.0 / 0.0	**TOPSOIL:** (50mm)										
	Silty **CLAY**, trace sand, trace gravel Stiff Brown Moist		1	SS	8		224		○		
			2	SS	12	▼			○		
			3	SS	10		223		○		
222.2 / 2.2											
	Firm		4	SS	6		222		○		
221.4 / 3.0											
			5	SS	11		221		○		
	Grey		6	SS	7		220		○		0 0 53 47
							219	2.7 +			
			7	SS	9		218		○		
								2.9 +			
			8	SS	8		217		○		
							216	3.3 +			
	Firm		9	SS	5		215		○		

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C4-02 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 4 N 4 881 593.6 E 294 623.3 ORIGINATED BY ES

HWY Line 5/Hwy 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.26 - 2015.05.26 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, trace sand Firm to Stiff Grey Wet										
			10	SS	6		214				
							213				
			11	SS	9		212				
211.1											
13.3	END OF BOREHOLE AT 13.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.04m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun 03/ 15 0.8 223.6										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: 20 40 60 80 100

WATER CONTENT (%): 20 40 60

+ 3, × 3: Numbers refer to Sensitivity

20 15 5 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C7-01 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 7 N 4 881 939.6 E 295 537.5 ORIGINATED BY ES

HWY Line 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.22 - 2015.05.22 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
232.9	GROUND SURFACE										
0.0	Silty **CLAY** Firm to Stiff Brown Moist		1	SS	7				○		
232.2							232				
0.7	Very Stiff Dark Brown to Brown		2	SS	16				○		0 0 60 40
231.5							231				
1.4			3	SS	8				○		
			4	SS	7				○		
							230				
			5	SS	10				○		0 0 54 46
							229	+ 3.1			
	Grey		6	SS	12				○		
							228				
			7	SS	15		227		○		
225.7							226				
7.2	Becoming sandy to with sand, occasional inferred cobbles Very Stiff		8	SS	16		225		○		0 34 47 19
224.2							224				
8.7			9	SS	12				○		
223.1											
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No C7-01 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 7 N 4 881 939.6 E 295 537.5 ORIGINATED BY ES

HWY Line 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.22 - 2015.05.22 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \quad 5}$ (%) STRAIN AT FAILURE
$\frac{}{10}$

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C7-02 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 7 N 4 881 898.7 E 295 547.1 ORIGINATED BY ES

HWY Line 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.22 - 2015.05.22 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
231.9	GROUND SURFACE										
0.0	Silty **CLAY**, occasional rootlets Firm to Stiff Dark Brown Moist		1	SS	6						0 0 68 32
			2	SS	8		231				
			3	SS	10		230				
	Brown										
			4	SS	9		229				
			5	SS	9						
227.8							228	3.7			
4.1	Becoming sandy to with sand Very Stiff Brown to Grey Moist		6	SS	17		227				0 34 48 18
226.3											
5.6	Occasional inferred cobbles		7	SS	13		226				
			8	SS	12		225				
							224				
			9	SS	25		223				
222.1											
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C7-02 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 7 N 4 881 898.7 E 295 547.1 ORIGINATED BY ES

HWY Line 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.22 - 2015.05.22 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	WATER LEVEL AT 2.3m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun 03/ 15 1.1 230.8										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C16-01 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 16/Ramp E-N N 4 881 927.4 E 294 800.6 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.25 - 2015.05.25 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
224.1	GROUND SURFACE										
0.0	Silty **CLAY**, trace to some sand, occasional rootlets Firm Dark Brown Moist		1	SS	6		224		○		
223.6 0.5	Silty **CLAY**, some sand Very Stiff Brown Moist		2	SS	17		223		○		
	Trace gravel		3	SS	15		222		○		
			4	SS	20				○		0 7 55 38
			5	SS	17		221		○		
	Grey						220				
			6	SS	16				○		
						▼	219				
	Stiff		7	SS	10		218		○		
			8	SS	8		217		○		
							216	+ 3.4			
	Firm Wet		9	SS	7		215		○		

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C16-01 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 16/Ramp E-N N 4 881 927.4 E 294 800.6 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.25 - 2015.05.25 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
213.9							214	3.0			
10.2	END OF BOREHOLE AT 10.2m. BOREHOLE OPEN AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.04m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun 03/ 15 5.6 218.5										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C16-02 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 16/Ramp E-N N 4 881 943.9 E 294 825.3 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.25 - 2015.05.25 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
225.1	GROUND SURFACE										
0.0	Silty **CLAY**, trace to some sand Firm Dark Brown Moist		1	SS	5		225		○		
224.6 0.5	Silty **CLAY**, some sand, trace gravel Very Stiff to Stiff Brown Moist		2	SS	20		224		○		
			3	SS	21		223		○		
			4	SS	13				○		
			5	SS	14		222		○		
	Occasional sand pockets Brown to Grey Moist		6	SS	11		221		○		0 0 63 37
	Firm to Stiff Grey Wet		7	SS	7		220		○		
			8	SS	8		219		○		
			9	SS	10		218	+ 2.7	○		
							217	+ 3.0	○		
							216		○		

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 + 5 (%) STRAIN AT FAILURE
10

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C16-02 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 16/Ramp E-N N 4 881 943.9 E 294 825.3 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.25 - 2015.05.25 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
214.9							215	2.6			
10.2	END OF BOREHOLE AT 10.2m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C17-01 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 17/Ramp W-N N 4 881 577.1 E 294 868.8 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.20 - 2015.05.20 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
226.2	GROUND SURFACE										
0.0	Silty **CLAY**, mixed with organics, trace to some sand, occasional rootlets Soft to Firm Dark Brown Moist		1	SS	4		226		○		
225.4											
0.8	Silty **CLAY** Stiff Brown Moist		2	SS	8		225		○		
	Occasional sand pockets		3	SS	9	▽			⊖		0 0 73 27
			4	SS	11		224		○		
	Brown to Grey		5	SS	13		223		○		
			6	SS	14		222		○		3 16 52 29
	Trace gravel, some sand Grey Wet						221				
			7	SS	9		220		○		
							219	4.0 +			
	Becoming sandy to with sand, trace gravel Firm to Stiff		8	SS	7		218		○		1 34 43 22
								3.7 +			
			9	SS	9		217		○		

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C17-01 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 17/Ramp W-N N 4 881 577.1 E 294 868.8 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.20 - 2015.05.20 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
216.0	Continued From Previous Page										
10.2	END OF BOREHOLE AT 10.2m. WATER LEVEL AT 2.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.						216	2.8			

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No C17-02 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 17/Ramp W-N N 4 881 605.2 E 294 890.7 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.20 - 2015.05.20 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
226.6	GROUND SURFACE										
0.0	Silty **CLAY**, mixed with organics, some sand, occasional roots and rootlets Firm Dark Brown Moist		1	SS	6		226				
			2	SS	6						
			3	SS	7		225				
224.4											
2.2	Silty **CLAY**, trace to some sand Stiff Brown Moist		4	SS	9		224				0 12 62 26
	Grey		5	SS	10		223	3.5			
	Trace gravel Wet		6	SS	12		222				
			7	SS	9		221				
							220	3.7			
			8	SS	5		219				
							218	3.1			
			9	SS	13		217				
216.8											
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No C17-02 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 17/Ramp W-N N 4 881 605.2 E 294 890.7 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.20 - 2015.05.20 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	WATER LEVEL AT 1.3m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun 03/ 15 1.2 225.4										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \cdot 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C23-01 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 23 N 4 881 425.9 E 294 944.1 ORIGINATED BY ES

HWY 400/Coffey Rd. BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.21 - 2015.05.21 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
225.3	GROUND SURFACE										
0.0	Silty **CLAY**, some sand, occasional roots Firm Dark Brown		1	SS	7		225		○		
224.7	Moist										
0.6	Silty **CLAY**, trace sand Stiff to Very Stiff Brown Moist		2	SS	8		224		○		0 0 59 41
	Occasional roots and rootlets Dark Brown		3	SS	16				○		
	Grey		4	SS	16		223		○		
			5	SS	17	▽	222		○		
	Some sand, trace gravel		6	SS	12		221		○		0 18 43 39
			7	SS	11		220				
			8	SS	10		219		○		
							218				
							217	+ 2.8	○		
	Firm Wet		9	SS	7		216		○		

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 / 10 / 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C23-01 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 23 N 4 881 425.9 E 294 944.1 ORIGINATED BY ES

HWY 400/Coffey Rd. BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.21 - 2015.05.21 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
215.1	Continued From Previous Page										
10.2	END OF BOREHOLE AT 10.2m. WATER LEVEL AT 3.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.							2.7			

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C25-01 1 OF 1 METRIC

W.P. P-13-03 LOCATION Culvert 25 N 4 881 615.9 E 295 344.2 ORIGINATED BY ES

HWY Coffey Rd. BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.21 - 2015.05.21 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
228.1	GROUND SURFACE										
0.0	Silty **CLAY**, trace to some sand, occasional roots Firm Dark Brown Moist		1	SS	5		228				
227.2											
0.9	Silty **CLAY**, some sand, trace gravel Firm to Stiff Brown Moist		2	SS	7		227				0 0 52 48
			3	SS	14		226				
	Grey Moist		4	SS	11	▽					
	Wet		5	SS	10		225				0 0 63 37
			6	SS	5		224	2.7			
222.5							223	2.8			
5.6	END OF BOREHOLE AT 5.6m. WATER LEVEL AT 2.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPUG AND AUGER CUTTINGS TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C25-02 1 OF 1 METRIC

W.P. P-13-03 LOCATION Culvert 25 N 4 881 637.2 E 295 332.3 ORIGINATED BY ES

HWY Coffey Rd. BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.21 - 2015.05.21 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
227.5	GROUND SURFACE										
0.0 / 227.0	Silty **CLAY**, mixed with organics, trace to some sand, occasional roots Soft Dark Brown Moist		1	SS	4		227				0 9 66 25
0.5	Silty **CLAY**, trace sand, trace gravel Firm to Stiff Brown Moist		2	SS	7						
	Wet		3	SS	11		226				
224.5	Grey		4	SS	12		225				
3.0	Very Stiff		5	SS	18		224				
223.4											
4.1 / 222.3			6	SS	14		223				
5.2	END OF BOREHOLE AT 5.2m. WATER LEVEL AT 1.1m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun 03/ 15 0.3 227.2										

+ ³, × ³: Numbers refer to Sensitivity

15 (20 / 10) 5 (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C29-01 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 29/Ramp N-EW N 4 881 901.7 E 294 636.3 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.26 - 2015.05.26 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
222.8	GROUND SURFACE										
0.0	Silty **CLAY**, mixed with organics, some sand, occasional rootlets Firm Dark Brown Moist		1	SS	5						
222.2 / 0.6	Silty **CLAY**, trace sand Soft Brown Moist		2	SS	3		222				
	Trace gravel, occasional sand layers		3	SS	4		221				
220.5 / 2.3	**SAND**, trace gravel Very Loose Brown Wet		4	SS	2		220				
219.7 / 3.1	Stiff Grey Moist		5	SS	13		219				0 9 46 45
			6	SS	13		218				
			7	SS	9		217				
							216	4.0 +			
			8	SS	11		215				
	Firm		9	SS	7		214				
							213				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C29-01 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 29/Ramp N-EW N 4 881 901.7 E 294 636.3 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2015.05.26 - 2015.05.26 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
212.6								2.7			
10.2	END OF BOREHOLE AT 10.2m. WATER LEVEL AT 1.4m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun 03/ 15 2.0 220.8										

$+^3$, $\times^3$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C29-02 1 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 29/Ramp N-EW N 4 881 878.4 E 294 723.2 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Wash Boring/Tripod COMPILED BY AN

DATUM Geodetic DATE 2015.06.18 - 2015.06.18 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
223.6	GROUND SURFACE										
0.0	Silty **CLAY**, mixed with organics, roots and rootlets Firm Dark Brown Moist		1	SS	6		223	○	○		
223.1 0.5 222.8											
0.8	Silty **CLAY**, occasional organics and rootlets Soft to Firm Brown Moist		2	SS	2	▽		○	○		
	Some sand to sandy Brown to grey Wet		3	SS	5		222	○	○		
221.3											
2.3	Some sand, trace gravel Stiff to Very Stiff Grey Wet		4	SS	14		221	○	○		
			5	SS	16		220	○	○		
			6	SS	9		219	○	○		
			7	SS	16		218	○	○		
			8	SS	13		217	○	○		
			9	SS	7		216	○	○		
	Trace sand Firm						215	○	○		
							214	○	○		

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No C29-02 2 OF 2 METRIC

W.P. P-13-03 LOCATION Culvert 29/Ramp N-EW N 4 881 878.4 E 294 723.2 ORIGINATED BY ES

HWY 400 BOREHOLE TYPE Wash Boring/Tripod COMPILED BY AN

DATUM Geodetic DATE 2015.06.18 - 2015.06.18 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, trace sand Firm Grey Wet							2.8 +			
							213				
212.3			10	SS	7				○		
11.3	END OF BOREHOLE AT 11.3m. WATER LEVEL AT 1.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \cdot 10 \cdot 5}$ (%) STRAIN AT FAILURE

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 6/26/15

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SLAT47W-01 1 OF 1 METRIC

GWP# 83-00-00 LOCATION N 4 880 589.8 E 295 140.9 ORIGINATED BY JG

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2013.05.06 - 2013.05.06 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
227.2											
0.0	**ASPHALT:** (125mm)										
0.1	**SAND**, some gravel Brown Moist (FILL)		1	AS			227				
	Loose		1	SS	7						
225.8							226				
1.4	Silty **CLAY**, some sand, trace gravel Very Stiff to Stiff Brown Moist		2	SS	16						
225.0							225				
2.2	Grey		3	SS	11						
	Some organics		4	SS	15		224				Split spoon wet
223.5											
3.7	Silty **CLAY**, some sand, trace gravel Stiff Grey Moist (TILL)		5	SS	10		223				0 14 47 39
			6	SS	15						
	Inferred cobbles at 5.2m						222				
			7	SS	14		221				4 20 45 31
220.5											
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO BOTTOM WITH NO FREE WATER UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.0m, CUTTINGS TO 1.5m, CONCRETE TO 0.15m THEN ASPHALT COLD PATCH TO GROUND SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

ONTMT4S 1218.GPJ 2012TEMPLATE(MTO).GDT 8/26/13

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SLAT57W-01 1 OF 1 METRIC

GWP# 83-00-00 LOCATION N 4 882 249.2 E 294 702.6 ORIGINATED BY JG

HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2013.05.08 - 2013.05.08 CHECKED BY SKP

ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
228.2											
0.0 / 227.9	**ASPHALT:** (250mm)										
0.3	**SAND** and **GRAVEL**, trace silt Grey Moist (FILL)		1	AS			228				34 58 8 (SI+CL)
	Compact		1	SS	21		227		○		
226.8											
1.4	Clayey **SILT**, trace sand, trace gravel Very Stiff Brown Moist		2	SS	23		226		○		
			3	SS	24				○		
225.2											
3.0	Silty **CLAY**, trace sand, trace gravel Firm to Stiff Brown Moist		4	SS	6	▽	225		○		Field vane pushed to 4.0m, but would not turn
			5	SS	10		224		○		
	Grey Moist to Wet		6	SS	15		223		○		Split spoon wet
221.5							222				
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO BOTTOM AND WATER LEVEL AT 3.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.0m, CUTTINGS AND BENTONITE HOLEPLUG TO 1.5m, CONCRETE TO 0.15m, THEN ASPHALT TO SURFACE.										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 1218.GPJ 2012TEMPLATE(MTO).GDT 8/7/13

LOG OF BOREHOLE BH14-161

PROJECT: Geotechnical Investigation - Bradford South Servicing Linear Works
CLIENT: MMM Group Limited
PROJECT LOCATION: Town of Bradford West Gwillimbury
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan N 4882111.33 E 609962.19

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 203 mm
Date: Dec/04/2014

REF. NO.: 10000792
ENCL NO.:

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	ELEVATION	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
228.5								
0.0 / 228.2	**TOPSOIL:** 280mm	1	SS	5	228			
0.3 / 227.4	**FILL:** silty clay, trace sand, trace organics, brown, moist, firm to stiff.	2	SS	9	227			
1.1 / 226.2	**SILTY CLAY:** trace sand, brown, very moist, stiff to firm. interbedded silt seams below 1.5m	3	SS	6	226	90		
2.3 / 225.4	**CLAYEY SILT:** trace sand, contain dilated silt layers and silty clay layers, brown to grey, wet, stiff.	4	SS	12	225	125		
3.1 / 224.6	**SILT:** some clay to clayey, contains silty clay seams /layers, dilaton, grey, wet, compact.	5	SS	11	224	100	20.7	0 0 71 29
3.8 / 223.9	**SILTY CLAY:** trace to some sand, trace gravel, brown, moist to wet, stiff.	6	SS	9	223	50		
4.6	**CLAYEY SILT:** sandy, trace gravel, contain sandy silt layers, grey, moist to wet, firm to stiff. dilaton below 6.1m	7	SS	8	222	50		wet spoon
		8	SS	7	221			
		1	VANE					
		9	SS	3	220			
		2	VANE					
		3	VANE		219			
		10	SS	10		25	22.9	
218.7								
9.8	**END OF THE BOREHOLE**							

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

SPL SOIL LOG-2014-1WELL-DRAFT 10000792-LOG-FEB.5.2015 - COPY.GPJ SPL.GDT 2/8/15

LOG OF BOREHOLE BH14-161

PROJECT: Geotechnical Investigation - Bradford South Servicing Linear Works

CLIENT: MMM Group Limited

PROJECT LOCATION: Town of Bradford West Gwillimbury

DATUM: Geodetic

BH LOCATION: See Borehole Location Plan N 4882111.33 E 609962.19

DRILLING DATA

Method: Hollow Stem Auger

Diameter: 203 mm

Date: Dec/04/2014

REF. NO.: 10000792

ENCL NO.:

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m						
	Note: 1) Borehole was open upon completion.										

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

Appendix B

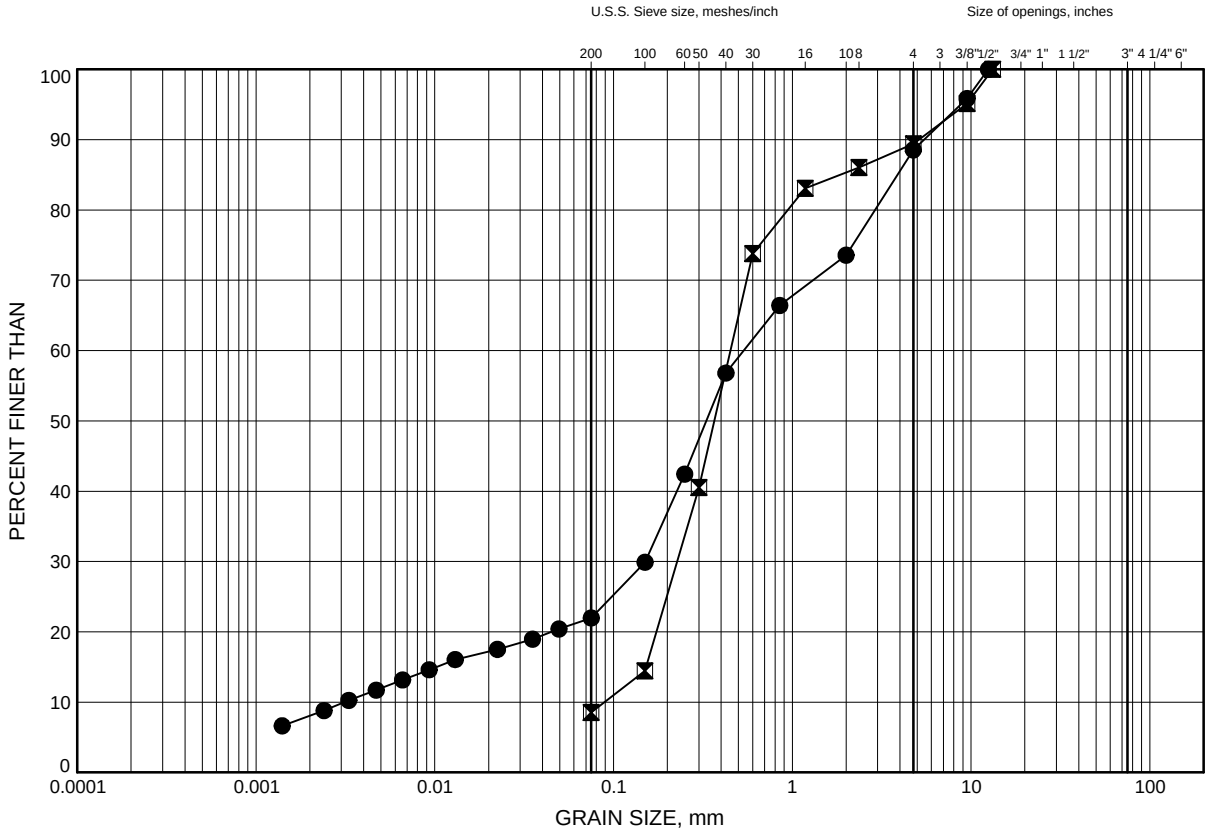
Laboratory Test Results

Foundation Engineering, Hwy. 400 and 5th Line

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-36	1.07	224.73
⊠	14-40	1.07	225.13

Date June 2015

W.P. P-13-03

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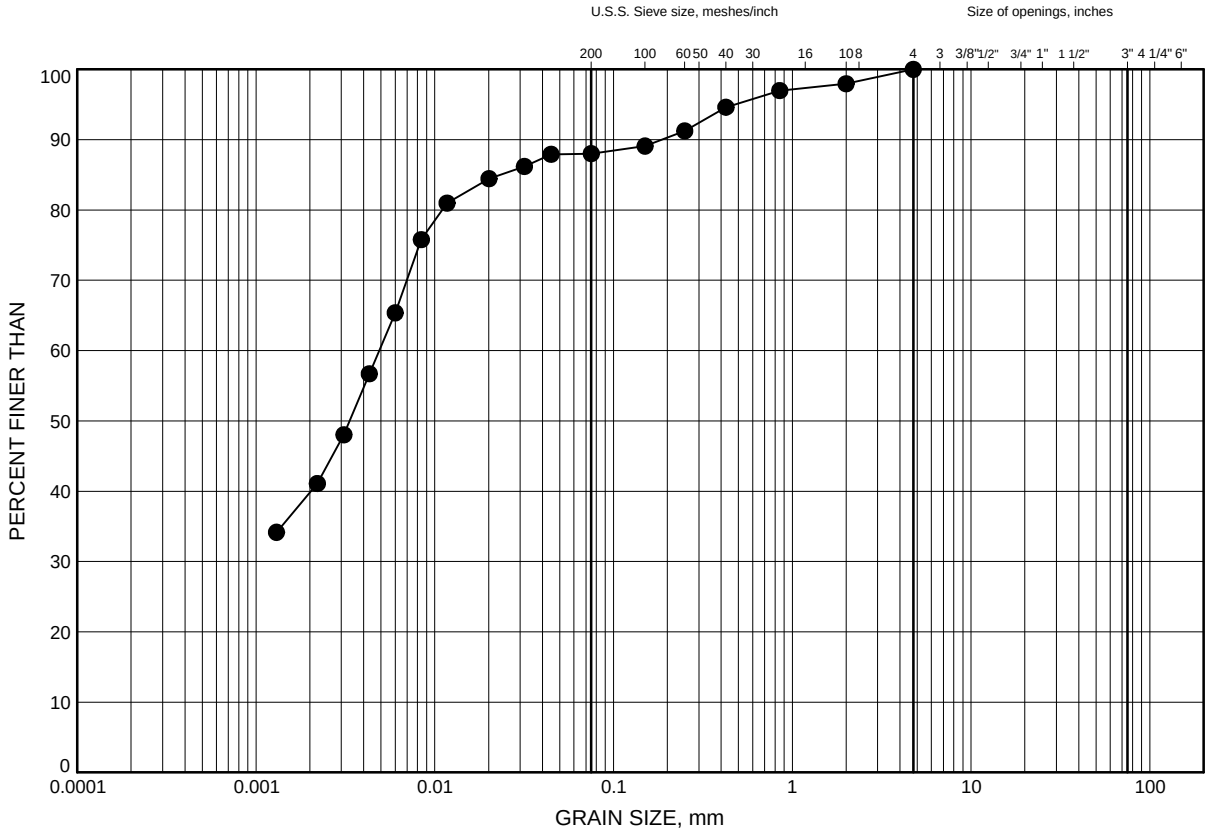
GRAIN SIZE DISTRIBUTION - THURBER 0615.GPJ 6/10/15

Foundation Engineering, Hwy. 400 and 5th Line

GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY CLAY FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-40	2.59	223.61

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Project P-13-03

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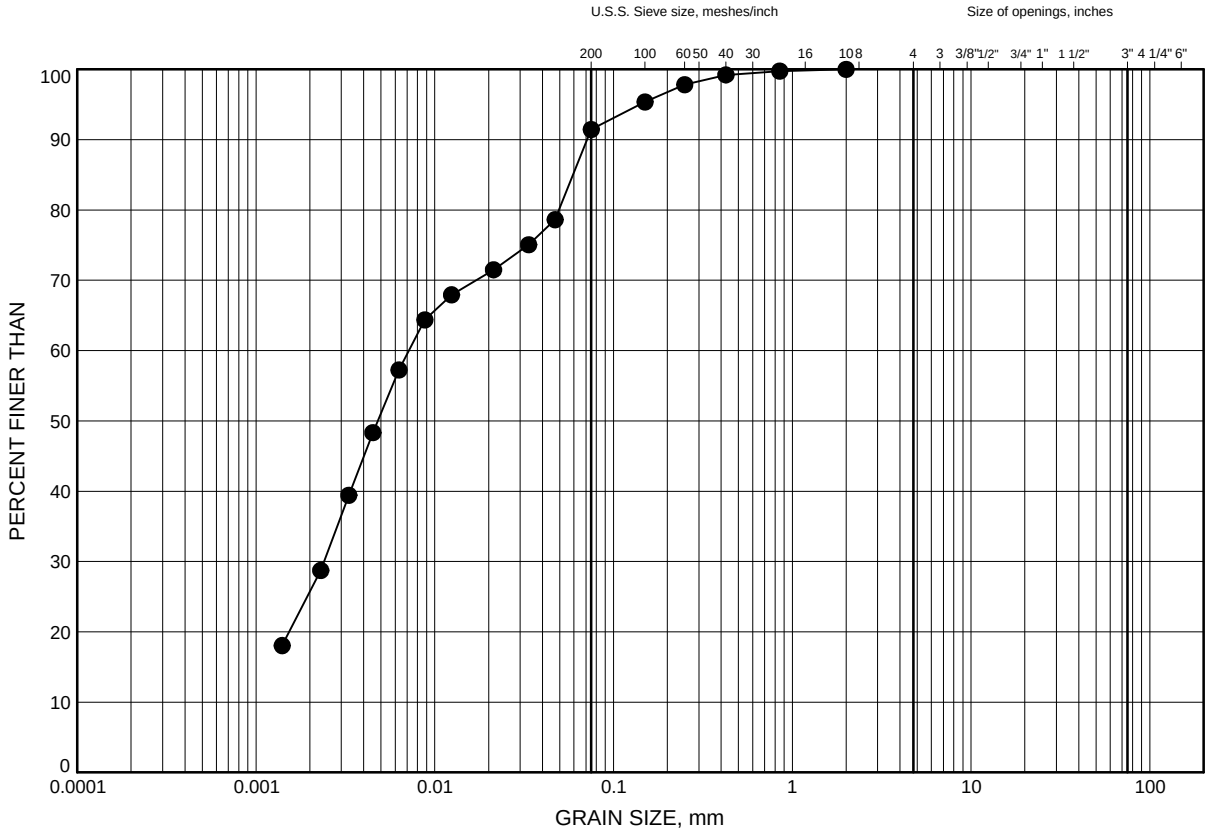
Foundation Engineering, Hwy. 400 and 5th Line

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY, mixed with organics



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C25-02	0.30	227.20

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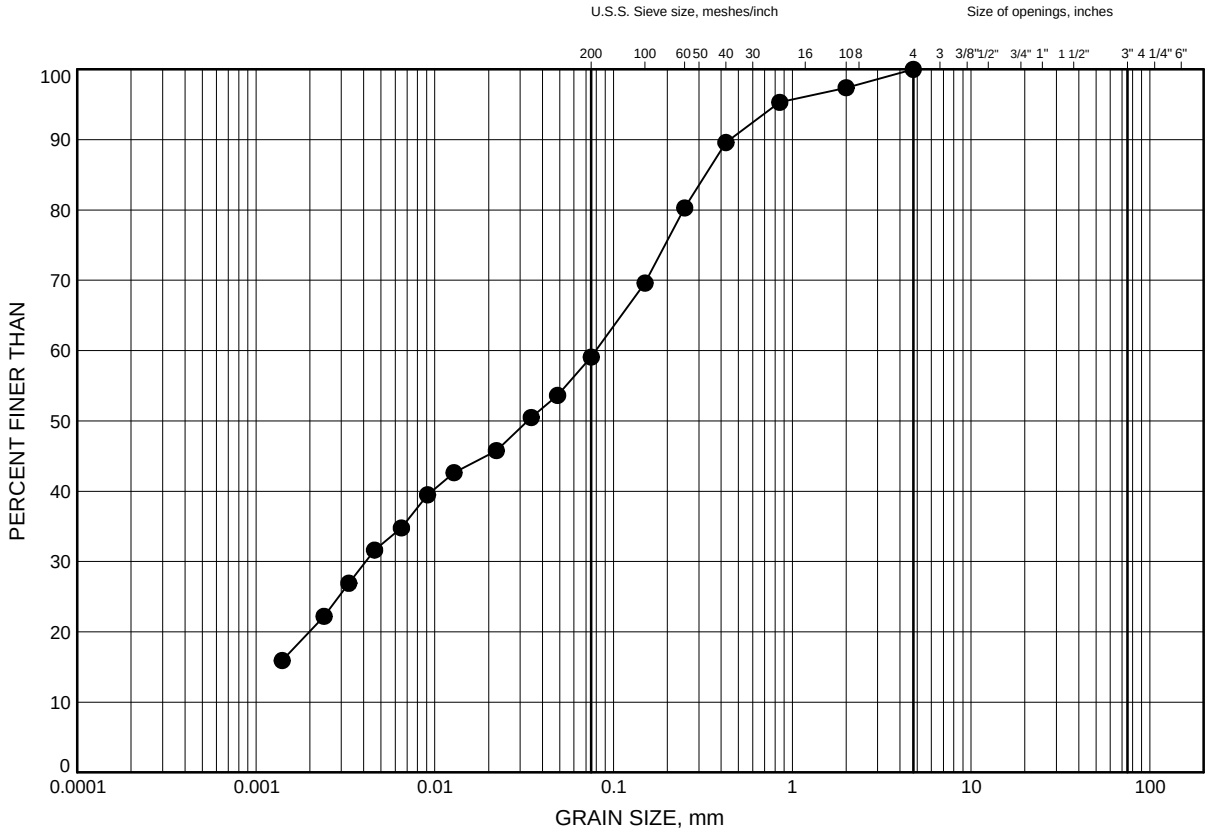
Foundation Engineering, Hwy. 400 and 5th Line

GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND & SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-15	1.07	221.13

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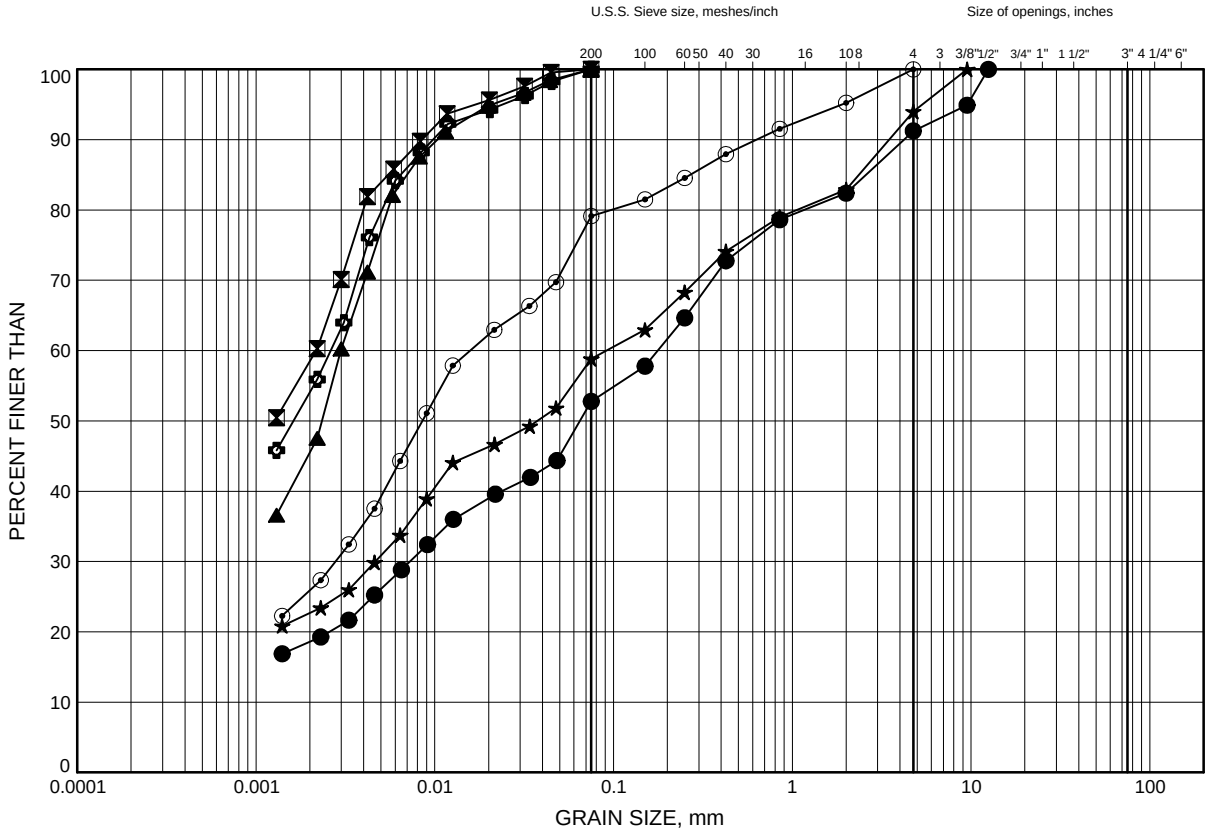
GRAIN SIZE DISTRIBUTION

FIGURE B5

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	13-24	0.30	223.08
⊠	13-24	3.35	220.03
▲	13-24	4.88	218.50
★	13-25	1.07	223.09
⊙	13-25	2.59	221.56
✿	13-25	6.40	217.75

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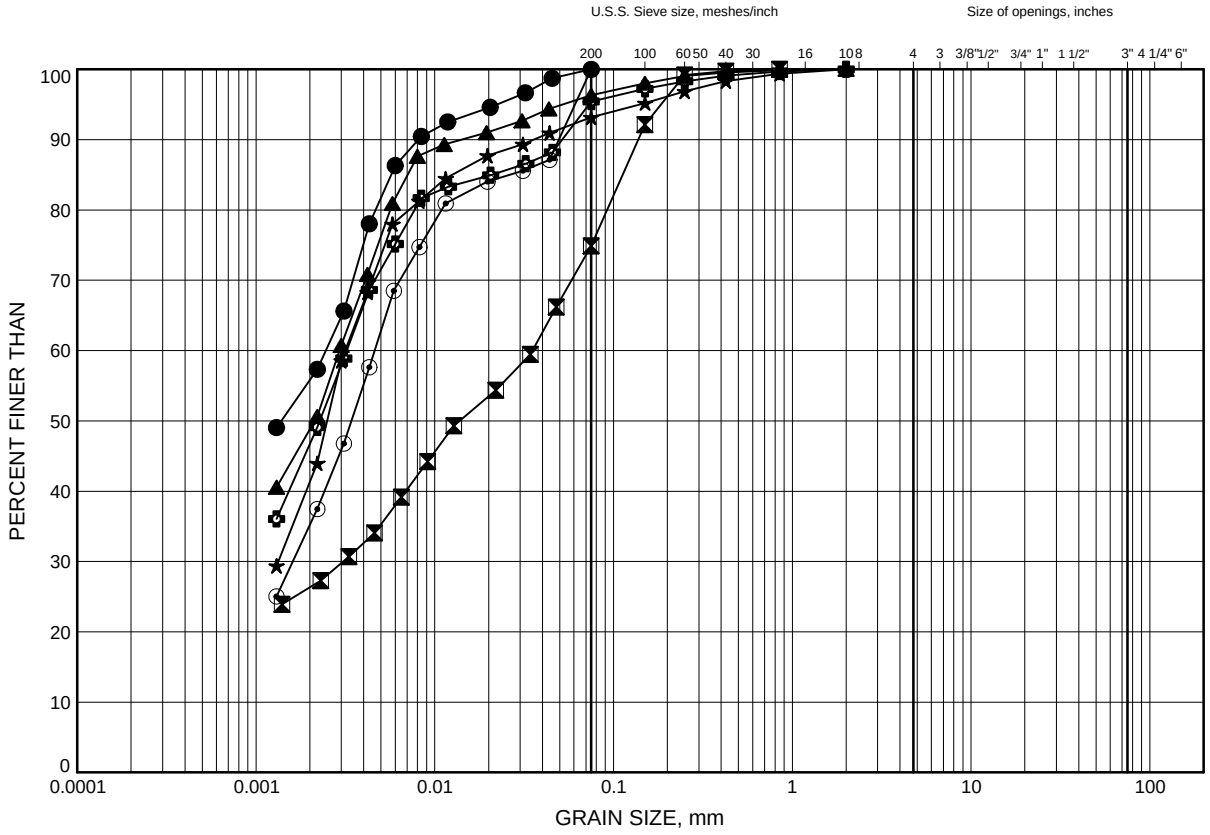
GRAIN SIZE DISTRIBUTION

FIGURE B6

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	13-25	10.97	213.18
⊠	14-07	1.07	220.56
▲	14-07	4.88	216.75
★	14-15	4.88	217.32
⊙	14-15	9.45	212.75
✿	14-15	18.59	203.61

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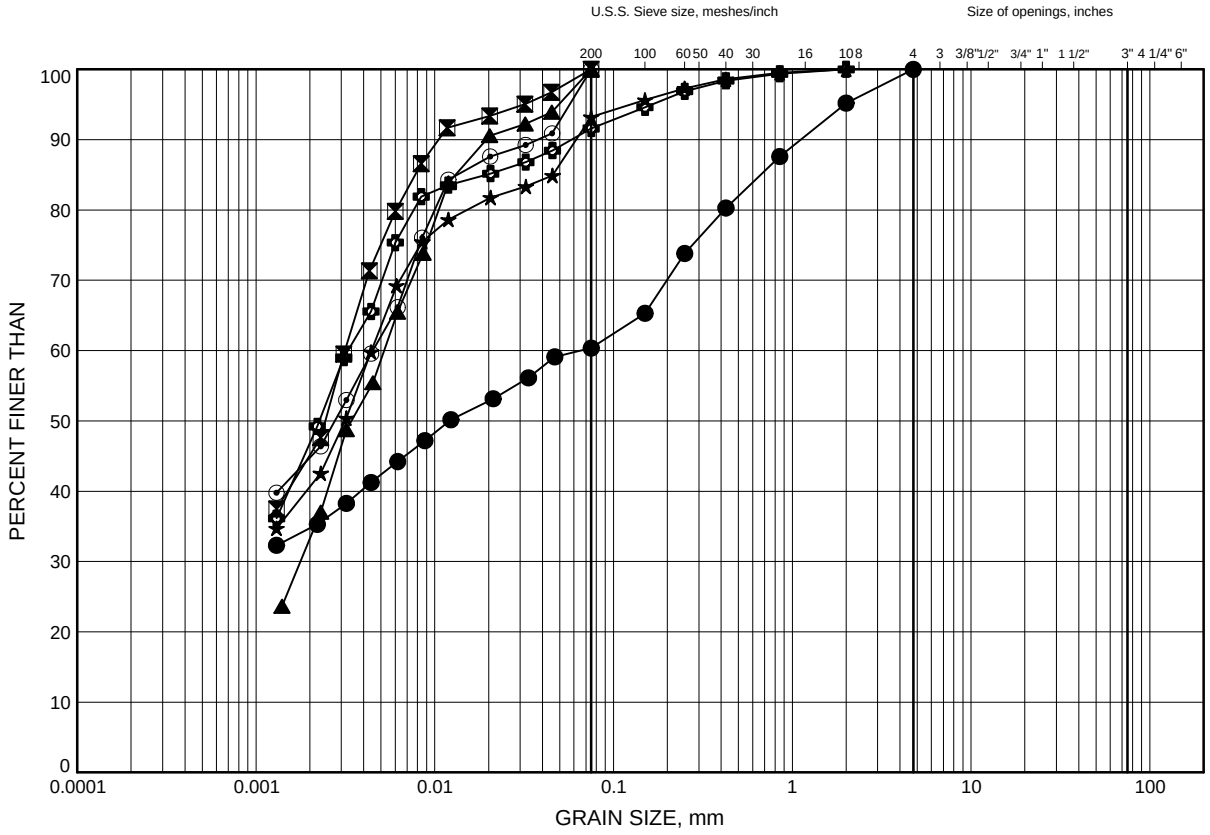
GRAIN SIZE DISTRIBUTION

FIGURE B7

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-15	19.89	202.31
⊠	14-16	3.35	217.86
▲	14-16	10.97	210.24
★	14-17	2.59	218.92
⊙	14-17	6.40	215.11
✿	14-17	12.50	209.01

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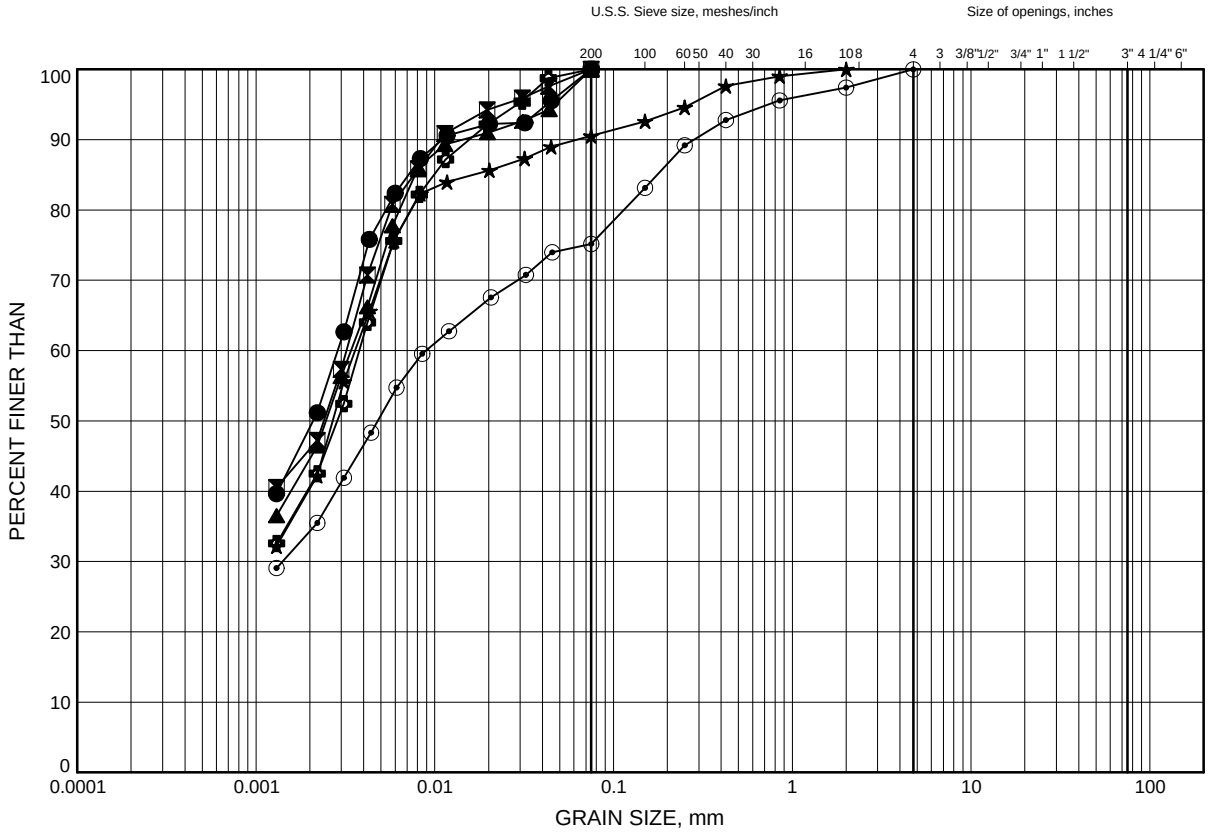
Foundation Engineering, Hwy. 400 and 5th Line

GRAIN SIZE DISTRIBUTION

FIGURE B8

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-36	3.35	222.45
⊠	14-36	7.92	217.88
▲	14-36	14.02	211.78
★	14-37	2.59	222.72
⊙	14-37	6.40	218.91
✿	14-37	10.97	214.33

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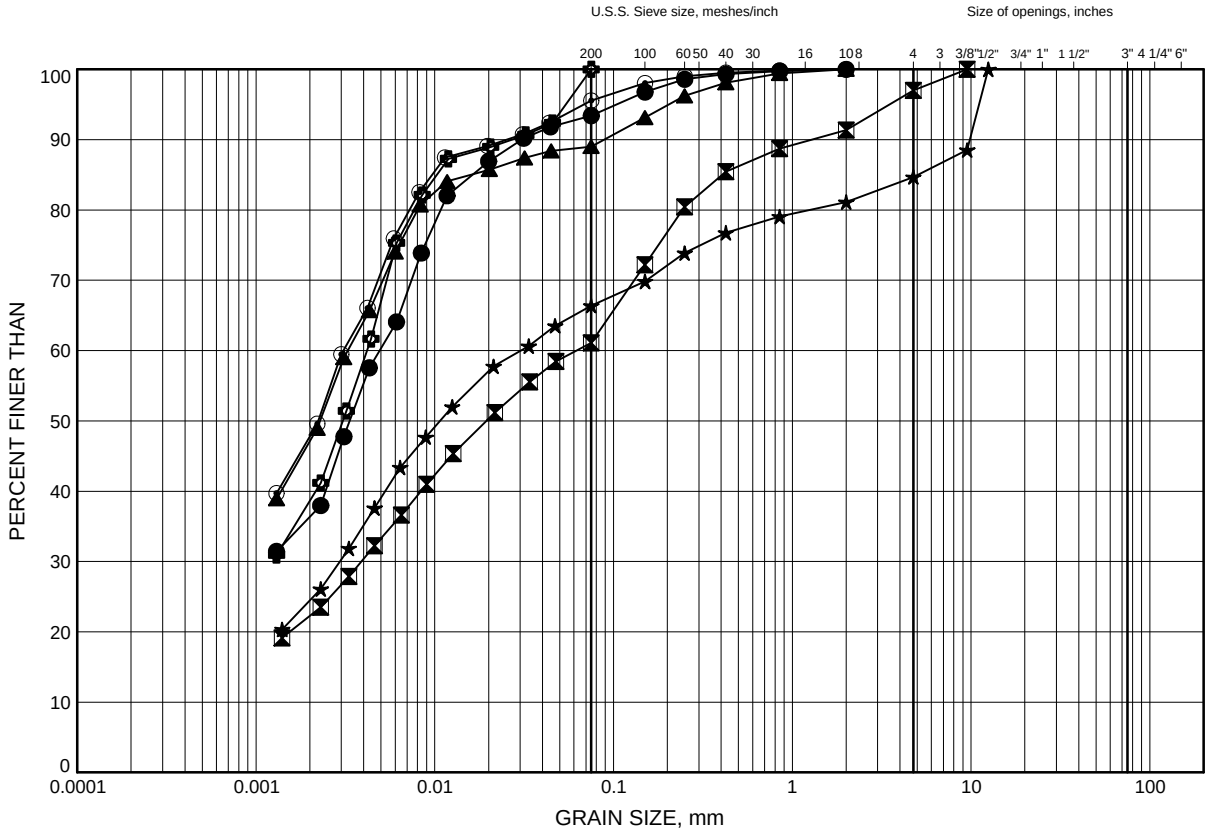
GRAIN SIZE DISTRIBUTION

FIGURE B9

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-39	2.59	224.01
⊠	14-39	7.92	218.68
▲	14-39	10.97	215.63
★	14-40	7.92	218.28
⊙	14-51	3.35	218.15
✿	14-51	7.92	213.58

Date June 2015

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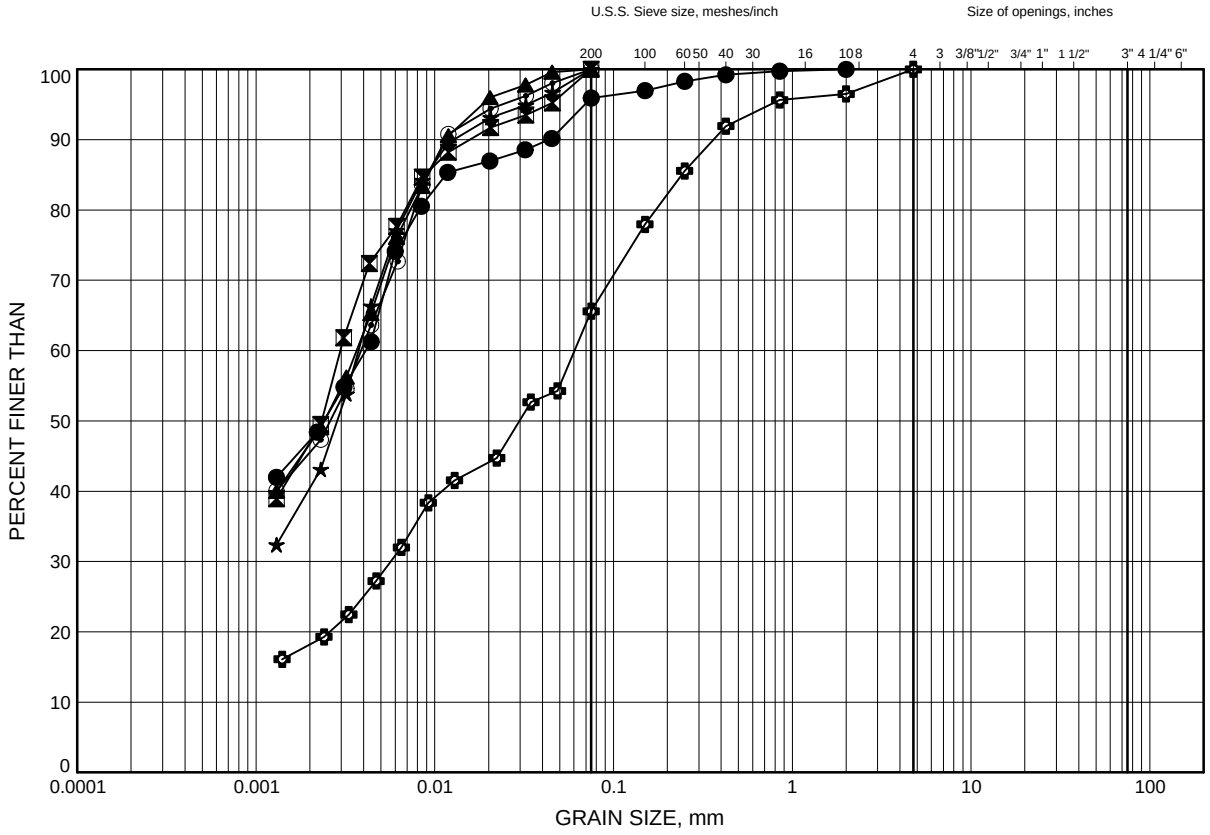
GRAIN SIZE DISTRIBUTION

FIGURE B10

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-51	10.97	210.53
⊠	C4-01	3.35	218.55
▲	C4-02	4.88	219.52
★	C7-01	1.07	231.83
⊙	C7-01	3.35	229.55
✿	C7-01	7.92	224.98

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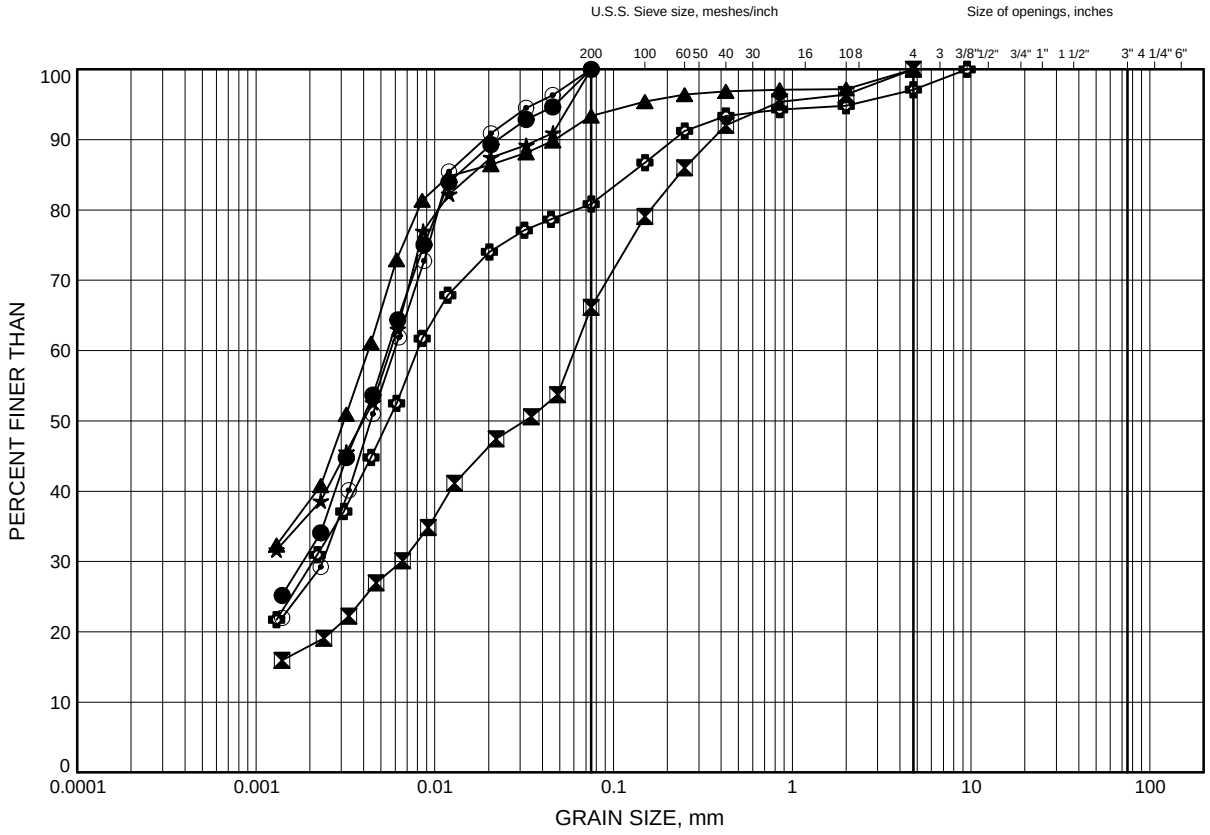
GRAIN SIZE DISTRIBUTION

FIGURE B11

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C7-02	0.30	231.60
⊠	C7-02	4.88	227.02
▲	C16-01	2.59	221.51
★	C16-02	4.88	220.22
⊙	C17-01	1.83	224.37
✿	C17-01	4.88	221.32

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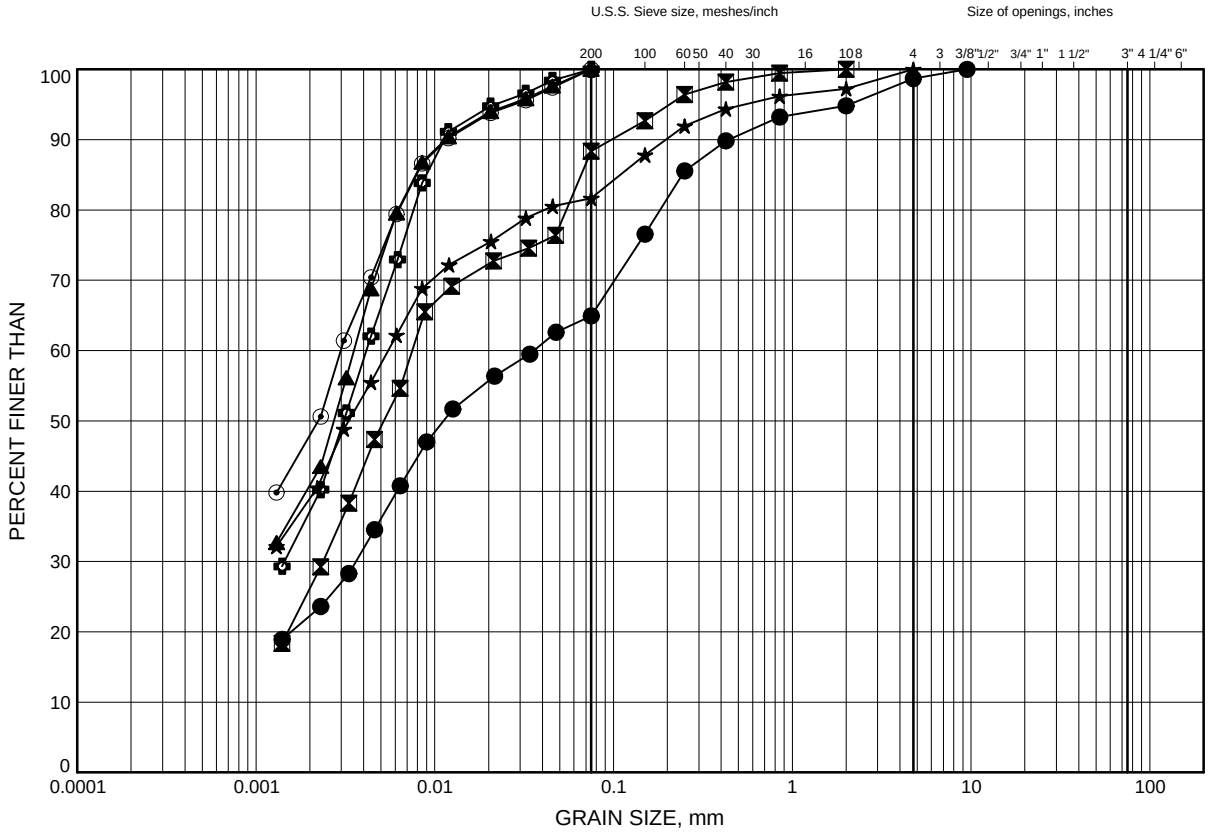
Foundation Engineering, Hwy. 400 and 5th Line

GRAIN SIZE DISTRIBUTION

FIGURE B12

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-01	7.92	218.28
⊠	C17-02	2.59	224.01
▲	C23-01	1.07	224.23
★	C23-01	4.88	220.42
⊙	C25-01	1.07	227.03
✿	C25-01	3.35	224.75

Date June 2015

W.P. P-13-03

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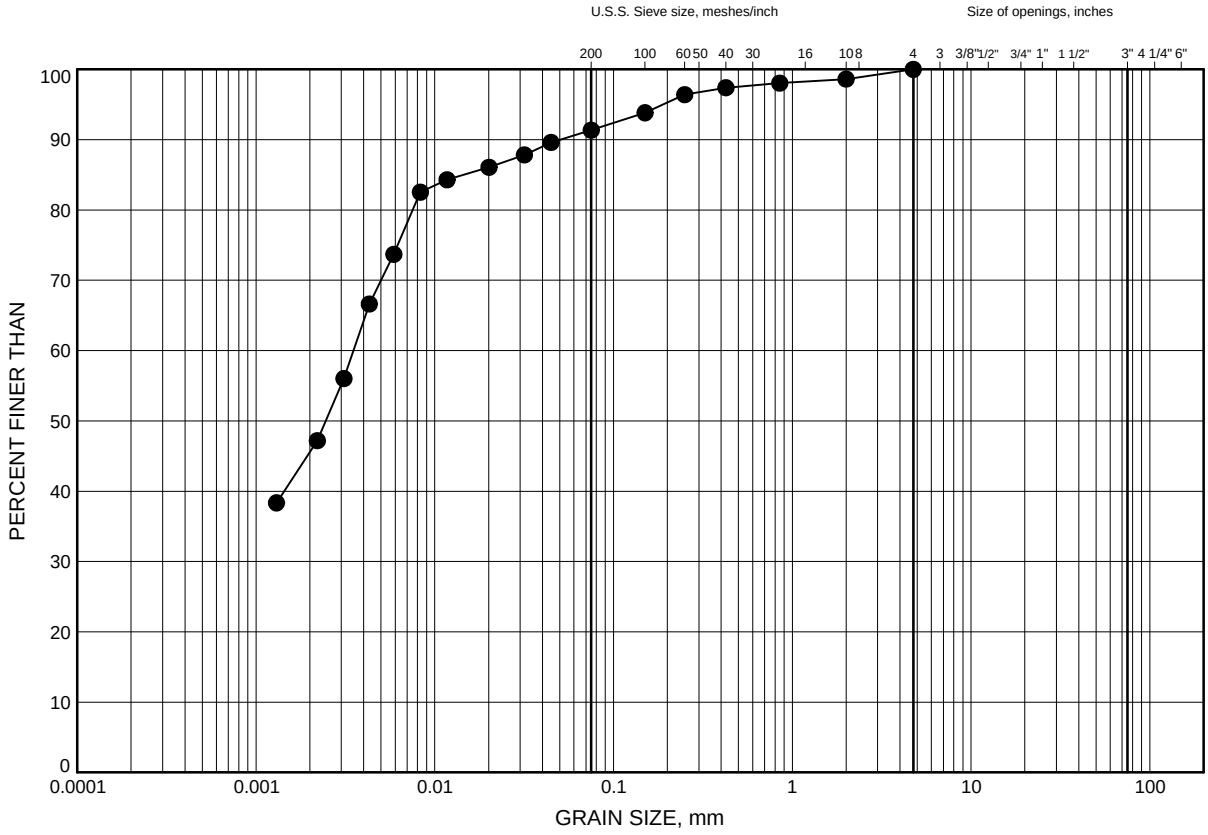
Foundation Engineering, Hwy. 400 and 5th Line

GRAIN SIZE DISTRIBUTION

FIGURE B13

SILTY CLAY



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C29-01	3.35	219.45

Date June 2015

W.P. P-13-03

THURBER

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Chkd. RPR

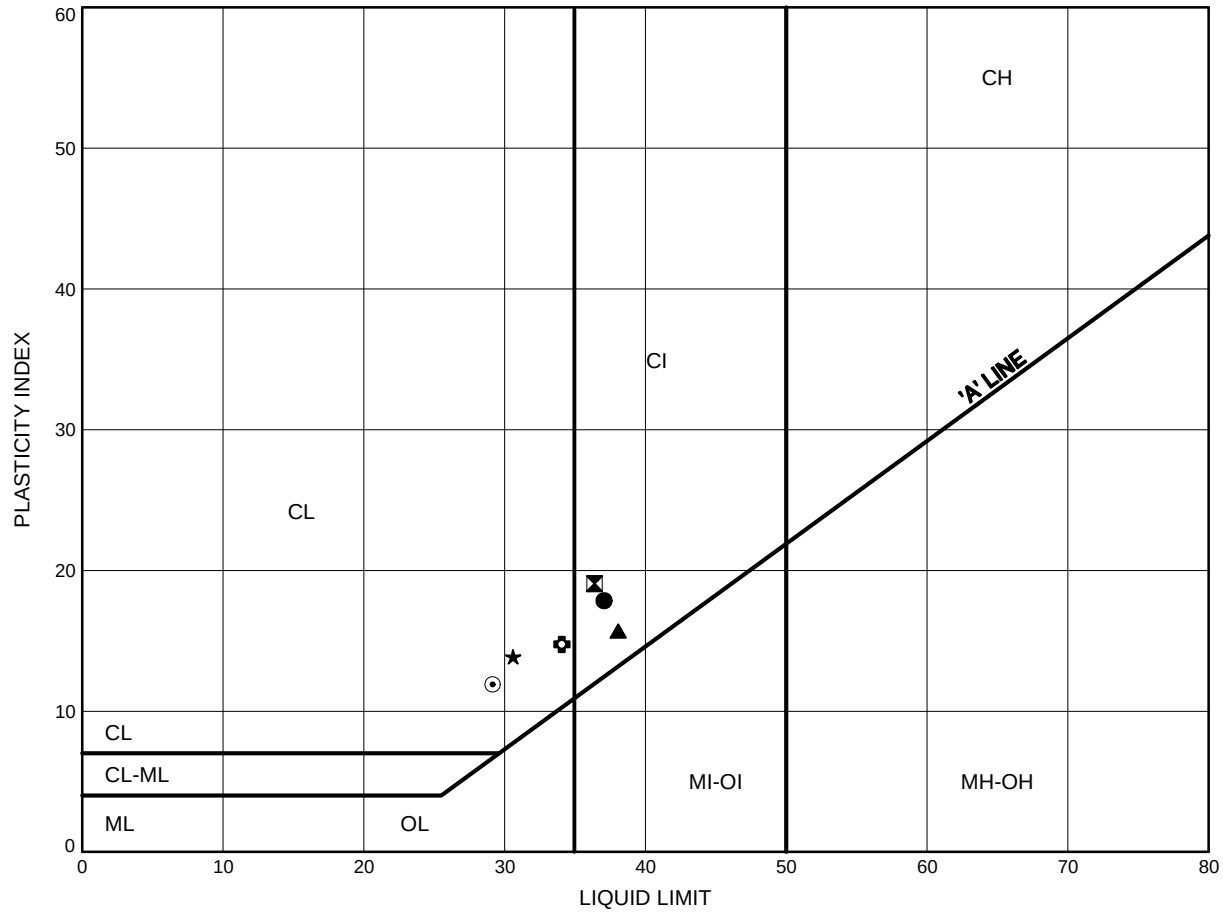
GRAIN SIZE DISTRIBUTION - THURBER 0615.GPJ 6/18/15

Foundation Engineering, Hwy. 400 and 5th Line

ATTERBERG LIMITS TEST RESULTS

FIGURE B14

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	13-24	3.35	220.03
⊠	13-24	4.88	218.50
▲	13-25	2.59	221.56
★	13-25	6.40	217.75
⊙	13-25	10.97	213.18
✿	14-07	4.88	216.75

Date June 2015

W.P. P-13-03

THURBER

Prep'd AN

Chkd. RPR

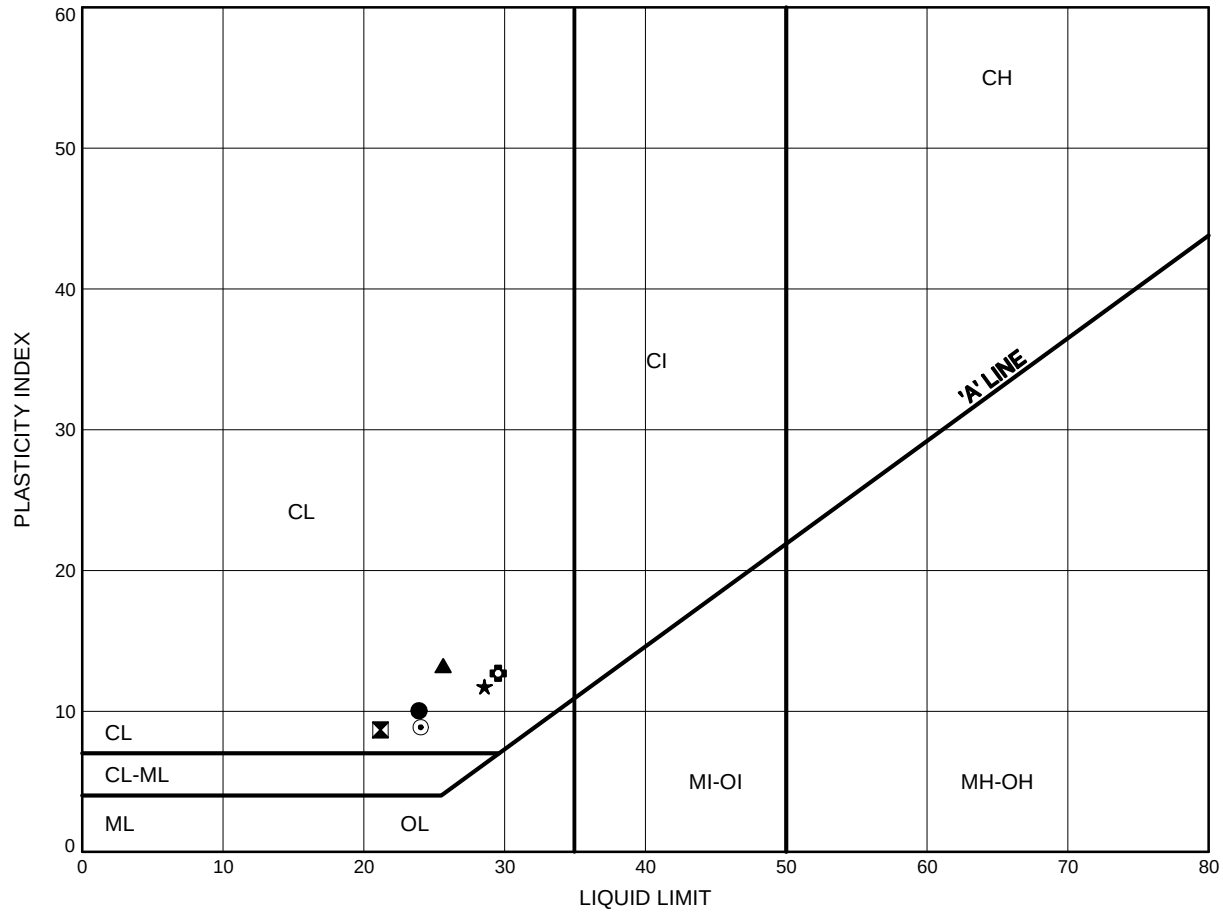
THURBALT 0615.GPJ 6/18/15

Foundation Engineering, Hwy. 400 and 5th Line

ATTERBERG LIMITS TEST RESULTS

FIGURE B15

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-15	4.88	217.32
⊠	14-15	9.45	212.75
▲	14-15	18.59	203.61
★	14-16	3.35	217.86
⊙	14-16	10.97	210.24
✿	14-17	6.40	215.11

Date June 2015

W.P. P-13-03

THURBER

Prep'd AN

Chkd. RPR

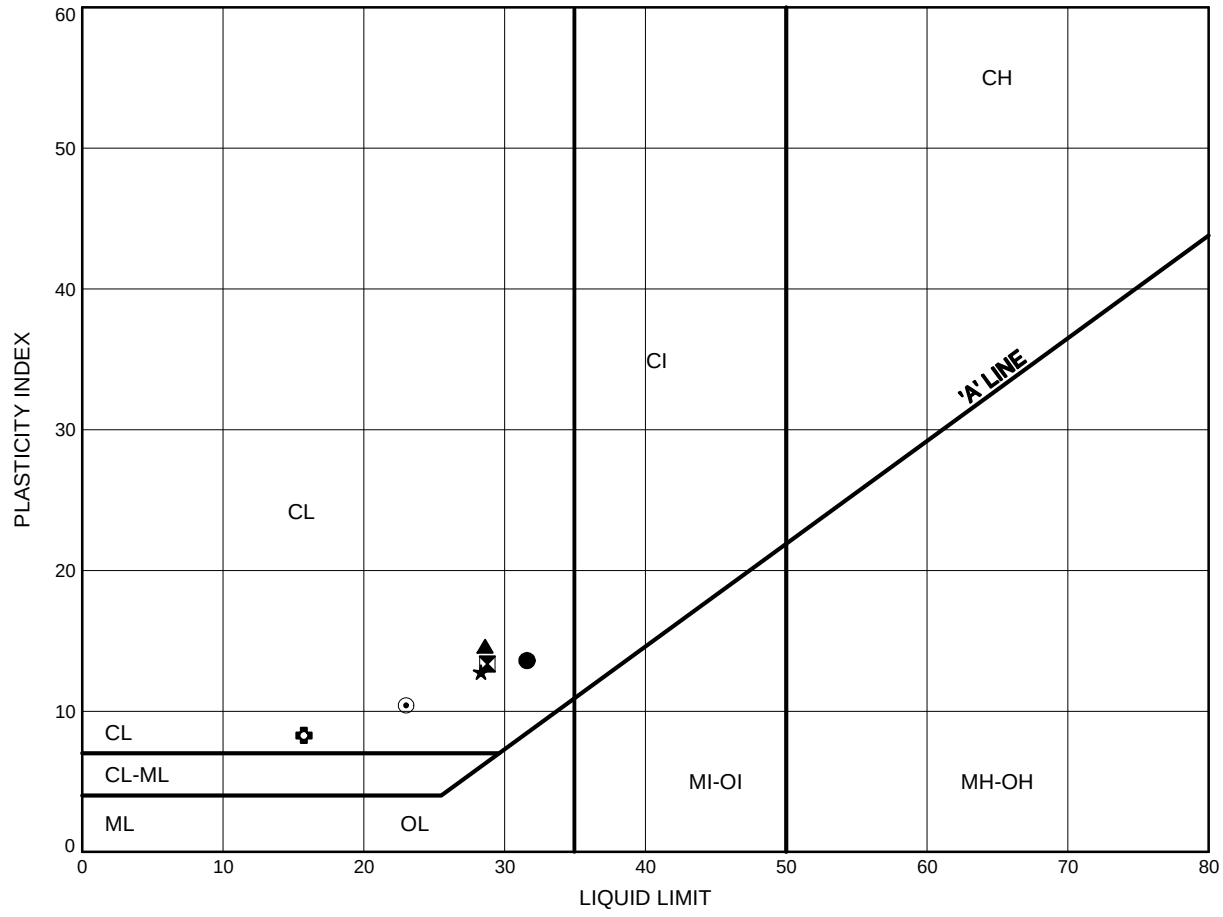
THURBALT 0615.GPJ 6/18/15

Foundation Engineering, Hwy. 400 and 5th Line

ATTERBERG LIMITS TEST RESULTS

FIGURE B16

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-36	3.35	222.45
⊠	14-36	7.92	217.88
▲	14-37	2.59	222.72
★	14-37	6.40	218.91
⊙	14-39	2.59	224.01
✿	14-39	7.92	218.68

Date June 2015

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Prep'd AN

Chkd. RPR

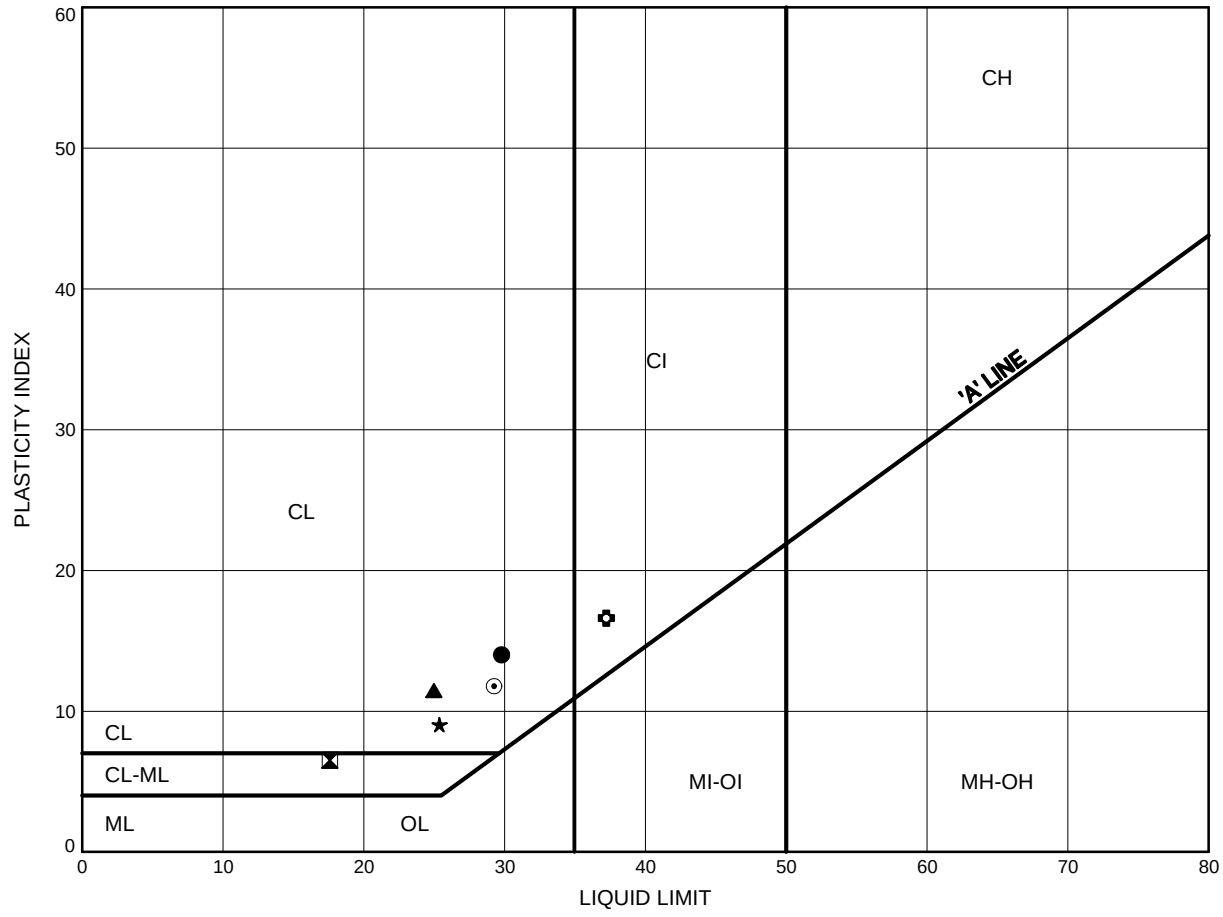
THURBALT 0615.GPJ 6/18/15

Foundation Engineering, Hwy. 400 and 5th Line

ATTERBERG LIMITS TEST RESULTS

FIGURE B17

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-39	10.97	215.63
⊠	14-40	7.92	218.28
▲	14-51	7.92	213.58
★	14-51	10.97	210.53
⊙	C4-01	3.35	218.55
✿	C7-01	1.07	231.83

Date June 2015

W.P. P-13-03

THURBER

Prep'd AN

Chkd. RPR

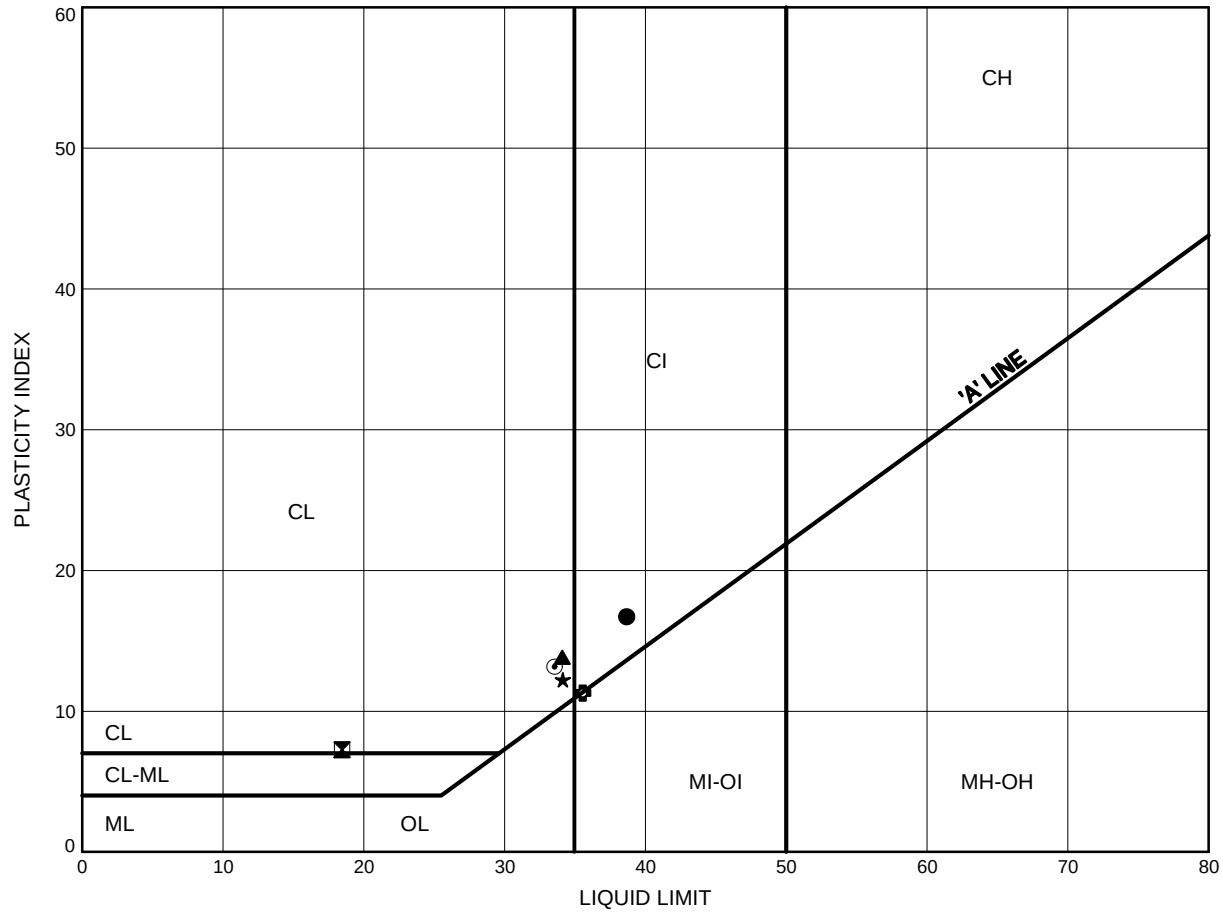
THURBALT 0615.GPJ 6/18/15

Foundation Engineering, Hwy. 400 and 5th Line

ATTERBERG LIMITS TEST RESULTS

FIGURE B18

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C7-01	3.35	229.55
⊠	C7-02	4.88	227.02
▲	C17-01	1.83	224.37
★	C17-02	2.59	224.01
⊙	C23-01	1.07	224.23
✿	C25-01	1.07	227.03

Date June 2015

W.P. P-13-03

THURBER

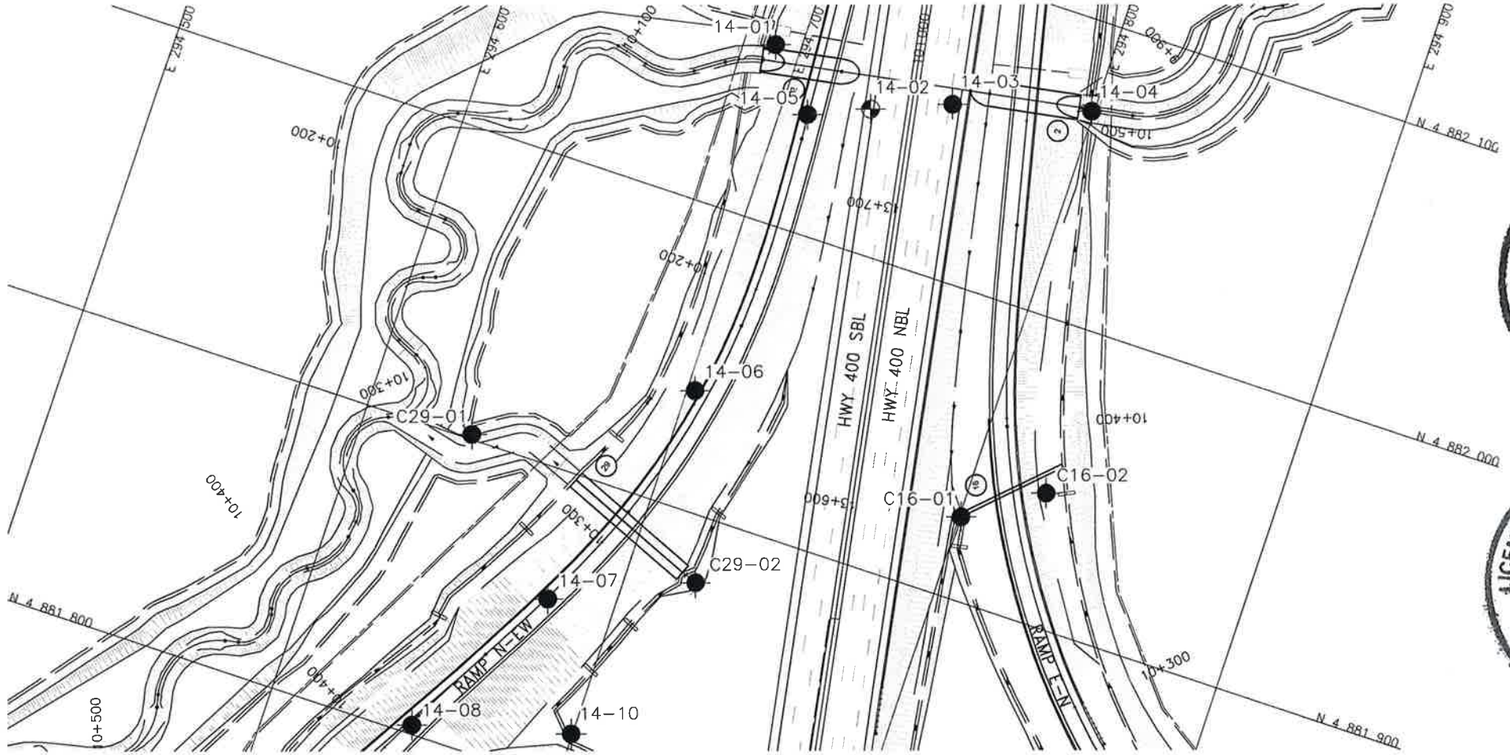
Prep'd AN

Chkd. RPR

THURBALT 0615.GPJ 6/18/15

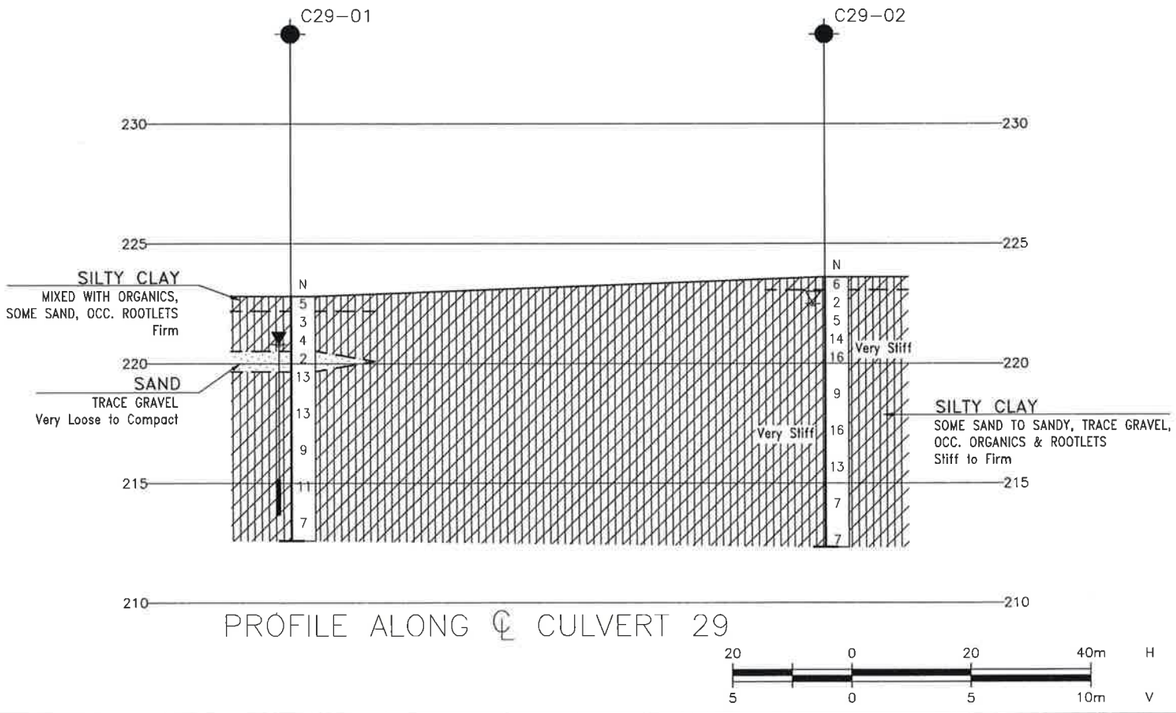
Appendix C

Drawings titled “Borehole Locations and Soil Strata”



PLAN

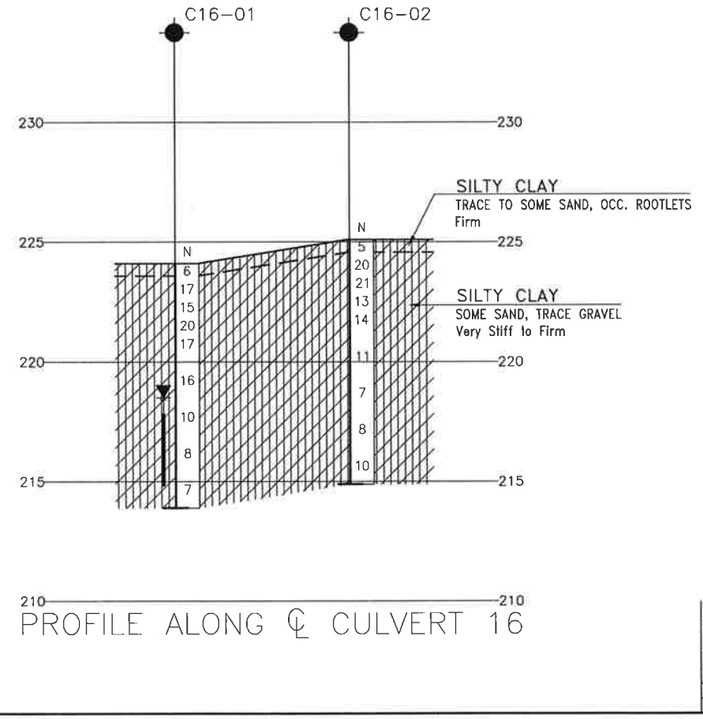
40 0 40 80m



PROFILE ALONG ℄ CULVERT 29

20 0 20 40m H

5 0 5 10m V



PROFILE ALONG ℄ CULVERT 16

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
S. PANG
Jul 28/15
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
July 28/15
PROVINCE OF ONTARIO

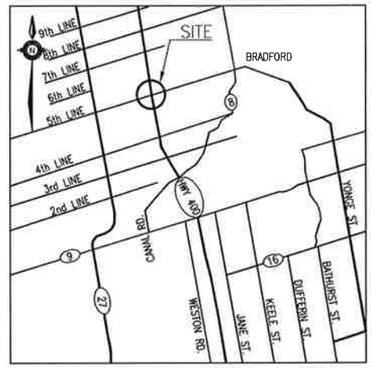
CONT No
WP No P-13-03

SHEET

HGHWAY 400 & LINE 5
CULVERTS 16 & 29
BOREHOLE LOCATIONS AND SOIL STRATA

URS

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
⧖	Water Level
⧗	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
C16-01	224.1	4 881 927.4	294 800.6
C16-02	225.1	4 881 943.9	294 825.3
C29-01	222.8	4 881 901.7	294 636.3
C29-02	223.6	4 881 896.7	294 668.4

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31D-611

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN RPR	CHK RPR	CODE	LOAD	DATE	JUL 2015
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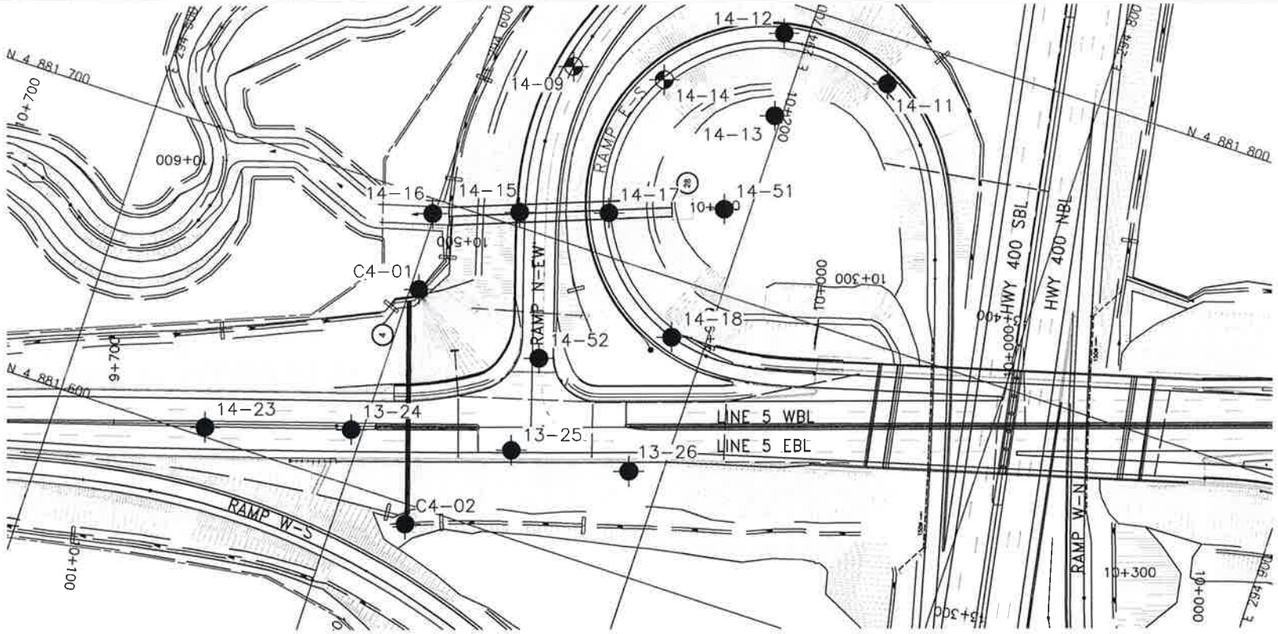
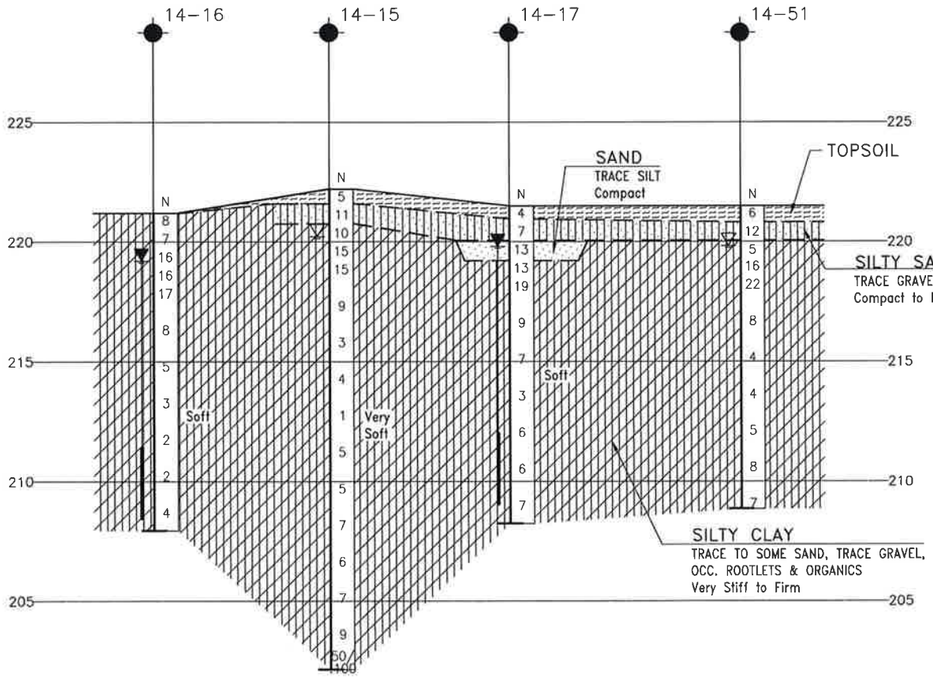
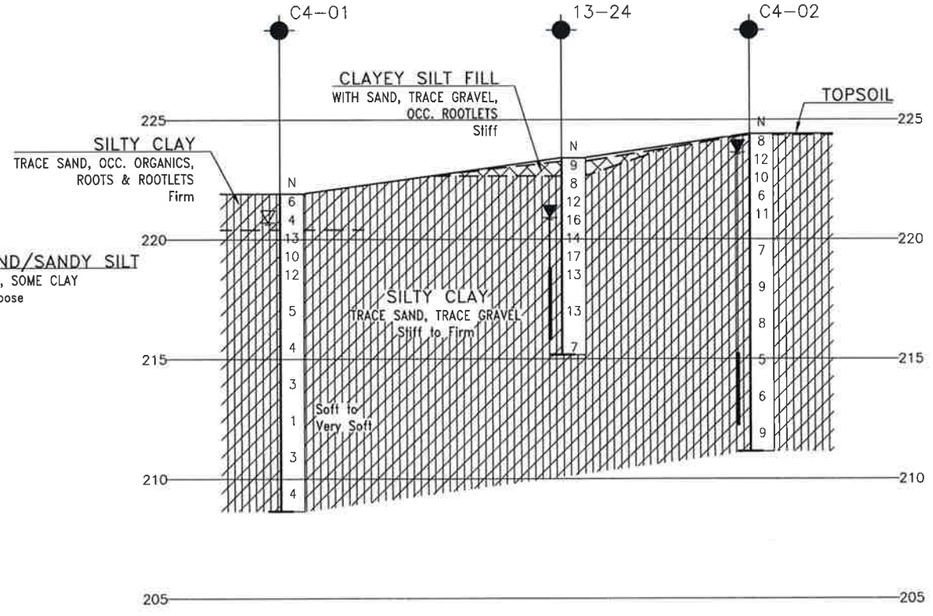


PLAN

40 0 40 80m



PROFILE ALONG ℄ CULVERT 28



PROFILE ALONG ℄ CULVERT 4

20 0 20 40m H

5 0 5 10m V

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
S. PANG
Jul 28/15
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Jly 28/15
PROVINCE OF ONTARIO

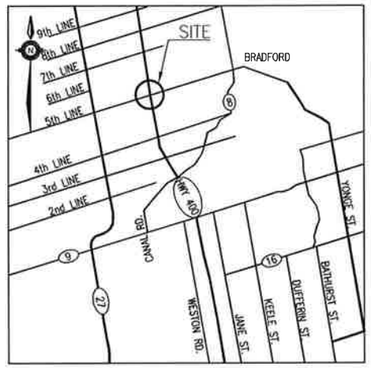
CONT No
WP No P-13-03

SHEET

HGHWAY 400 & LINE 5
CULVERTS 4 & 28
BOREHOLE LOCATIONS AND SOIL STRATA

URS

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▽	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
13-24	223.4	4 881 617.8	294 596.3
13-25	224.2	4 881 628.3	294 649.5
14-15	222.2	4 881 704.9	294 627.0
14-16	221.2	4 881 695.2	294 599.3
14-17	221.5	4 881 714.1	294 655.5
14-51	221.5	4 881 727.4	294 691.7
C4-01	221.9	4 881 669.6	294 602.9
C4-02	224.4	4 881 593.6	294 623.3

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31D-611

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK RPR	CODE	LOAD	DATE JUL 2015
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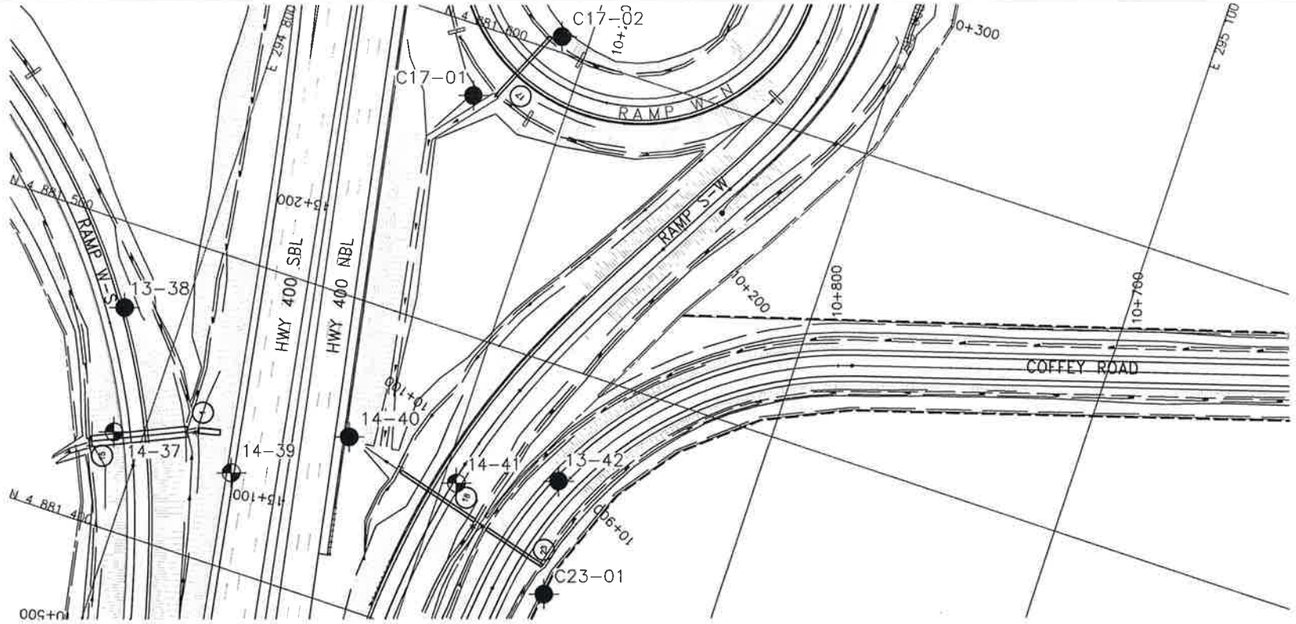
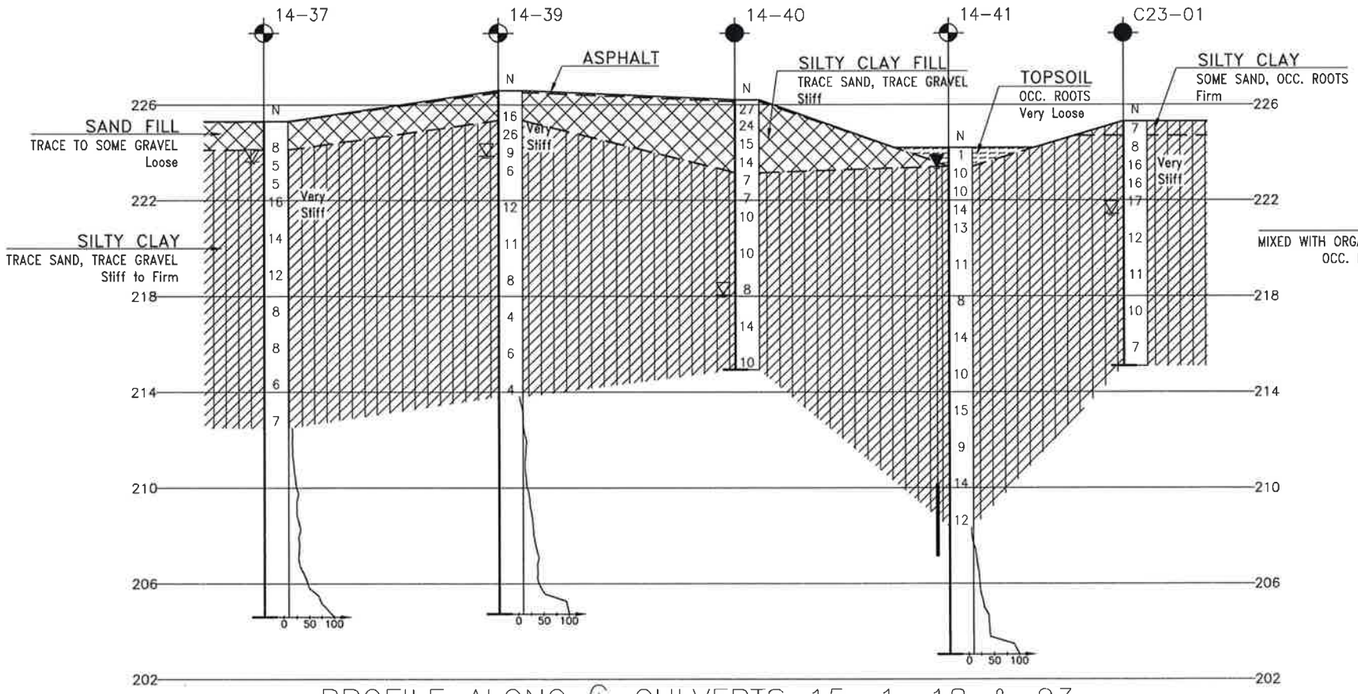


PLAN

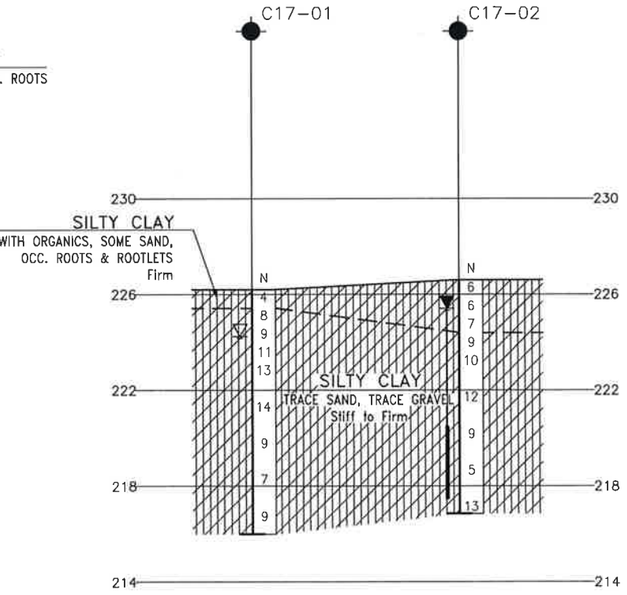
40 0 40 80m



PROFILE ALONG ℄ CULVERTS 15, 1, 18 & 23

20 0 20 40m H

5 0 5 10m V



PROFILE ALONG ℄ CULVERT 17

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
S. PANG
PROVINCE OF ONTARIO
Jul 28/15

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
PROVINCE OF ONTARIO
July 28/15

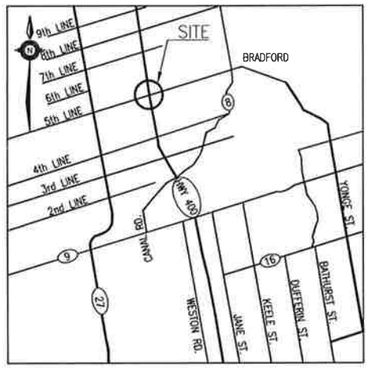
CONT No
WP No P-13-03

SHEET

HGHWAY 400 & LINE 5
CULVERTS 15, 1, 18, 23 & 17
BOREHOLE LOCATIONS AND SOIL STRATA

URS

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
14-37	225.3	4 881 431.9	294 790.5
14-39	226.6	4 881 431.3	294 831.9
14-40	226.2	4 881 455.2	294 865.6
14-41	224.2	4 881 451.9	294 904.5
C17-01	226.2	4 881 577.1	294 868.8
C17-02	226.6	4 881 605.2	294 890.7
C23-01	225.3	4 881 425.9	294 944.1

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31D-611

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK	RPR	CODE	LOAD	DATE	JUL 2015
DRAWN	AN	CHK	SKP	SITE	STRUCT	DWG	3

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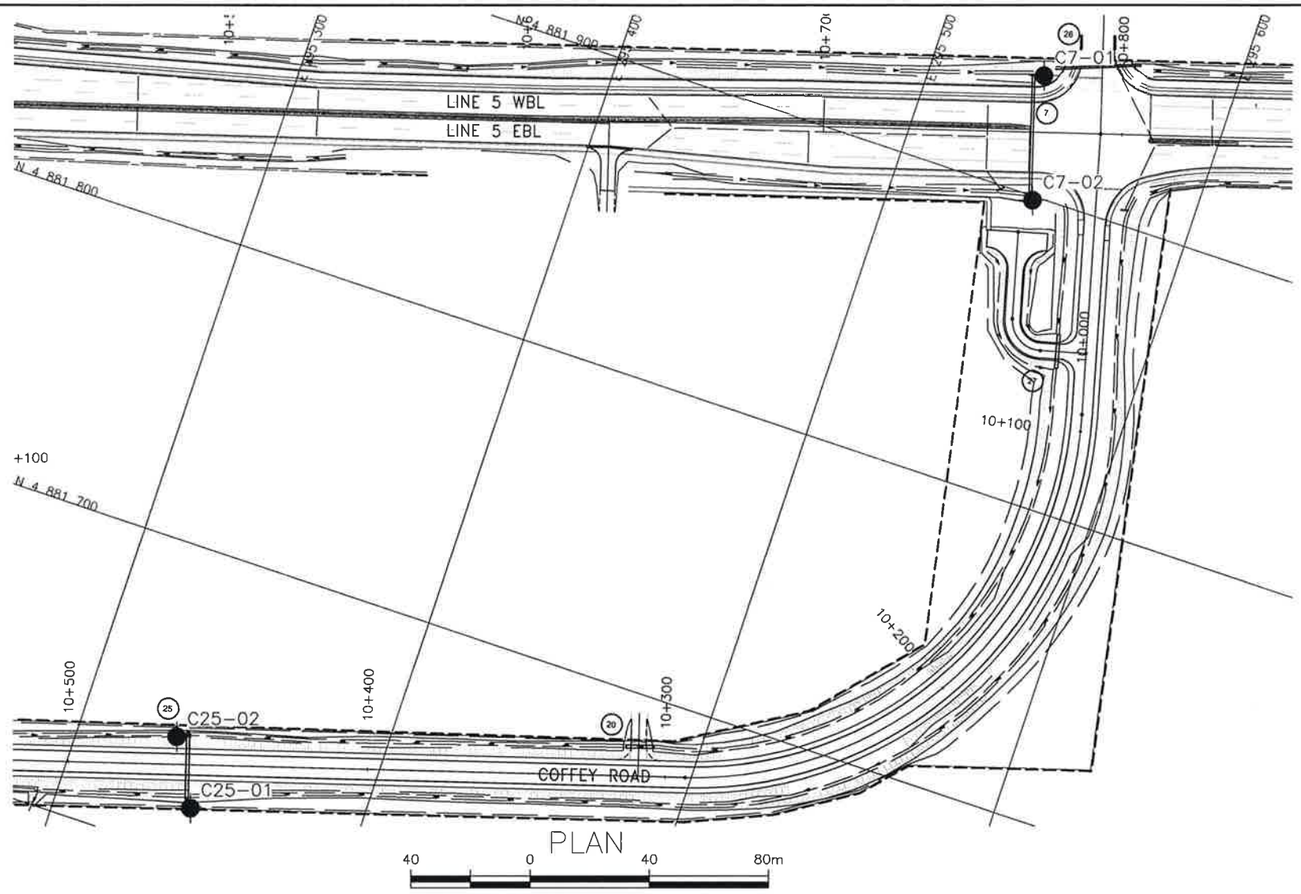
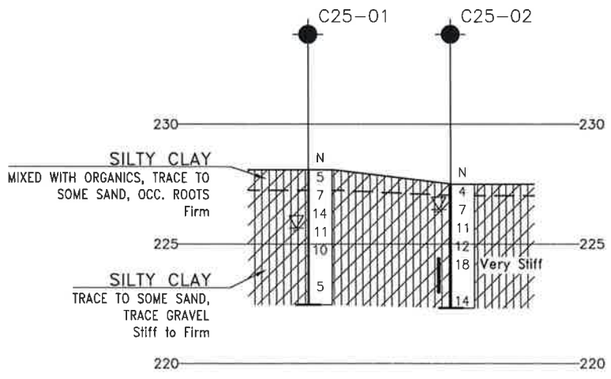
MINISTRY OF TRANSPORTATION, ONTARIO

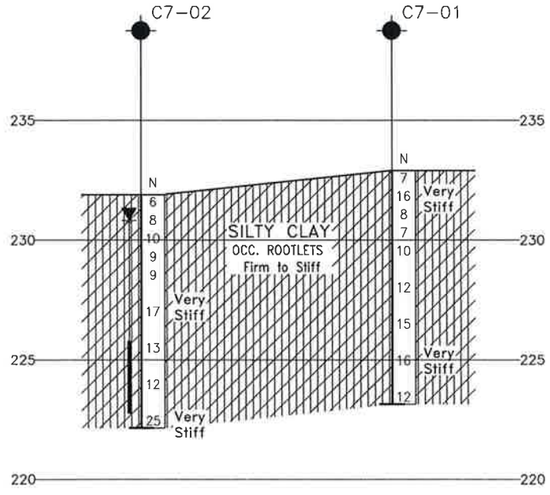


PLAN

40 0 40 80m



PROFILE ALONG ℄ CULVERT 25



PROFILE ALONG ℄ CULVERT 7

20 0 20 40m H

5 0 5 10m V

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
S. RANG
Jul 28/15
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
July 28/15
PROVINCE OF ONTARIO

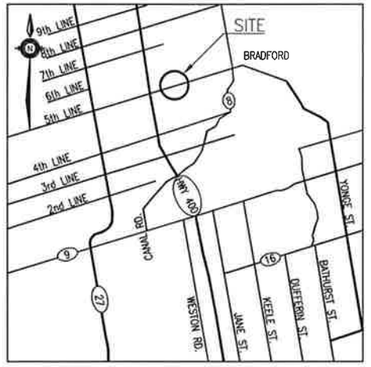
CONT No
WP No P-13-03

SHEET

HGHWAY 400 & LINE 5
CULVERTS 7 & 25
BOREHOLE LOCATIONS AND SOIL STRATA

URS

THURBER ENGINEERING LTD.



KEYPLAN

	LEGEND
⊕	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▼	Head Artesian Water
▮	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
C7-01	232.9	4 881 939.6	295 537.5
C7-02	231.9	4 881 898.7	295 547.1
C25-01	228.1	4 881 615.9	295 344.2
C25-02	227.5	4 881 637.2	295 332.3

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31D-611

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK	RPR	CODE		LOAD	DATE JUL 2015
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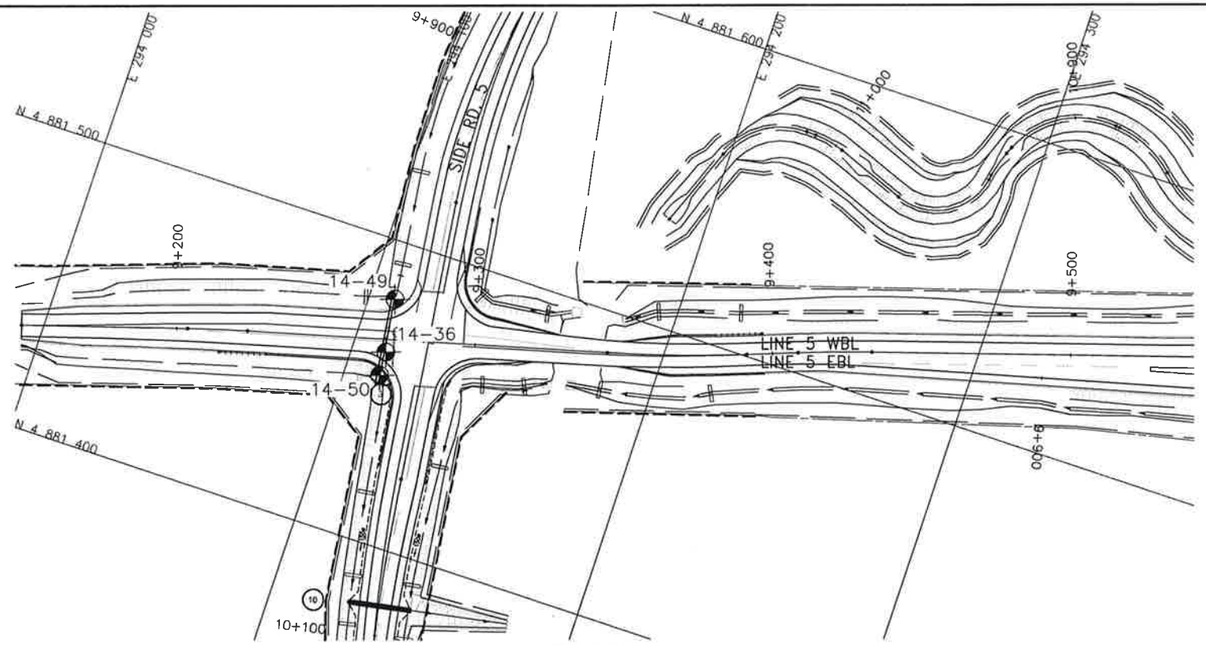
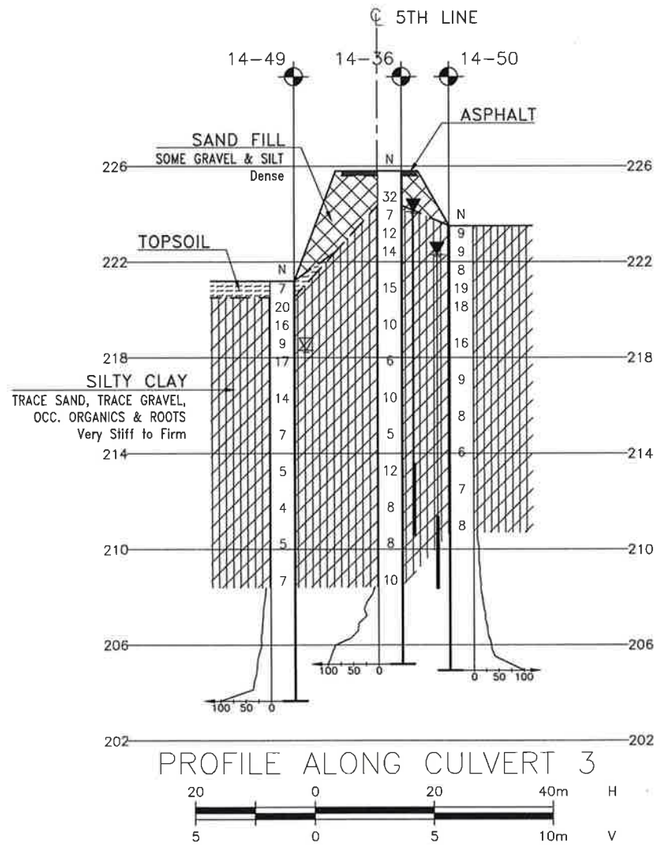


PLAN

40 0 40 80m



PROFILE ALONG CULVERT 3

20 0 20 40m H

5 0 5 10m V

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

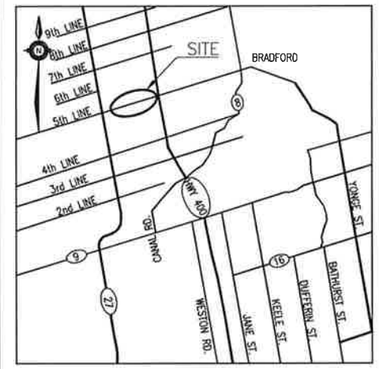
CONT No
WP No P-13-03

HGHWAY 400 & LINE 5
CULVERT 3
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

URS

THURBER ENGINEERING LTD.



KEYPLAN

	LEGEND
✦	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▽	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
14-36	225.8	4 881 463.2	294 111.3
14-49	221.2	4 881 481.0	294 108.6
14-50	223.5	4 881 455.2	294 111.7

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31D-611

LICENSED PROFESSIONAL ENGINEER
S. PANG
Jul 28/15
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
July 28/15
PROVINCE OF ONTARIO

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN RPR	CHK RPR	CODE	LOAD DATE JUL 2015
DRAWN AN	CHK SKP	SITE	STRUCT DWG 5

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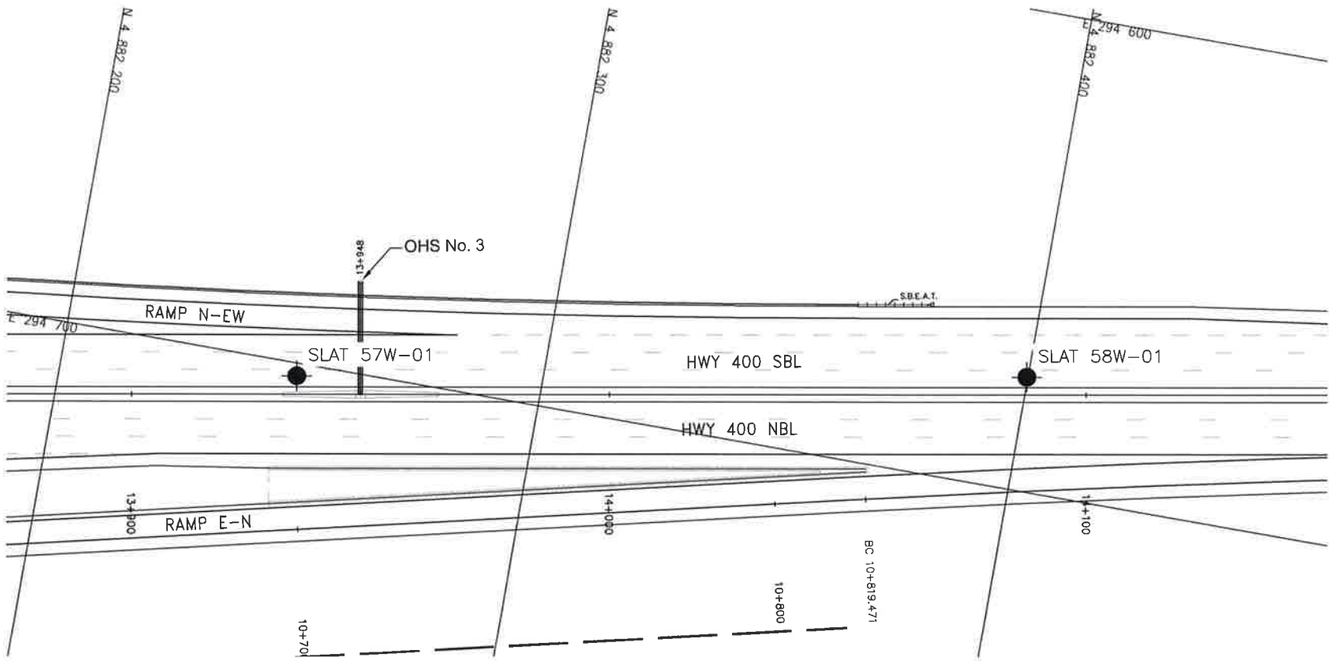
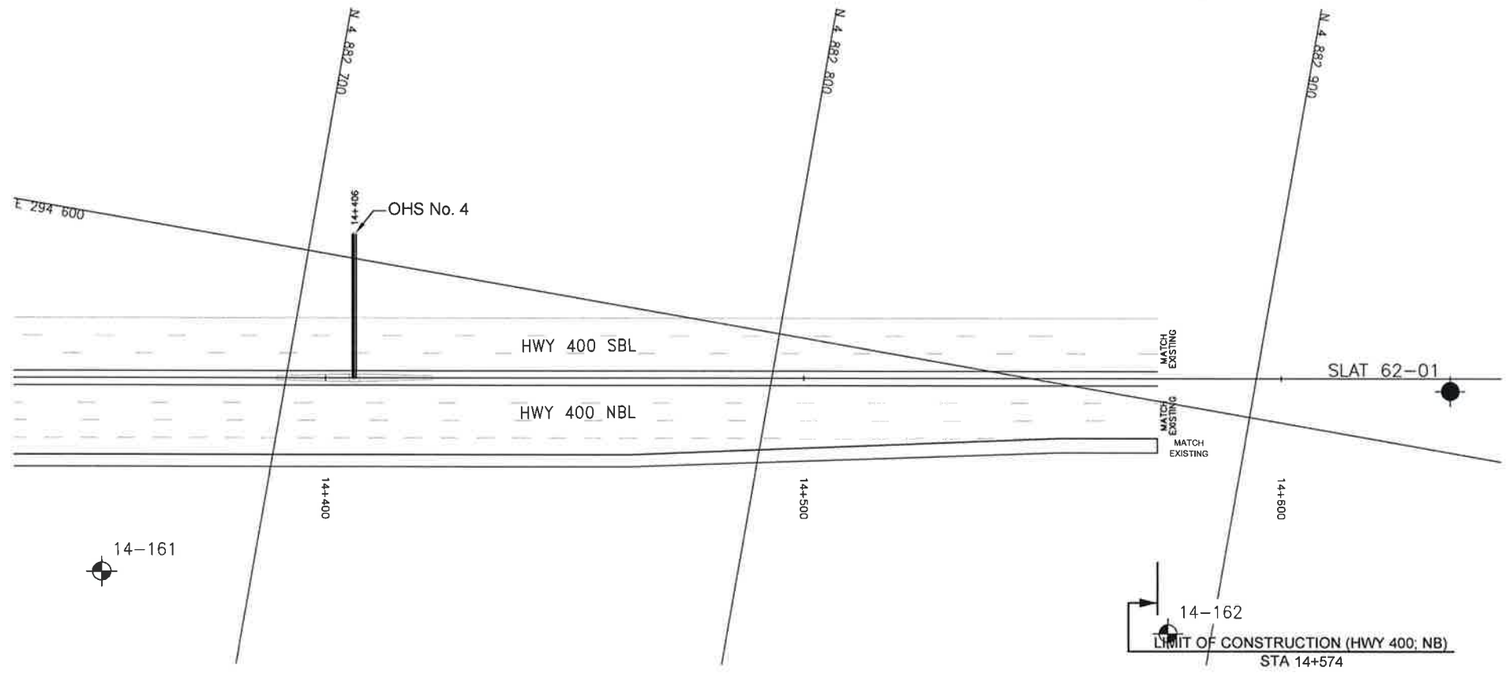




PLAN

25 0 25 50m

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
S. PANG
7/28/15
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
July 28/15
PROVINCE OF ONTARIO

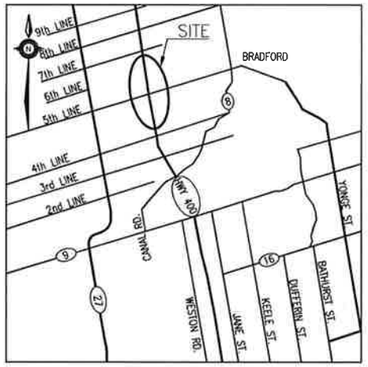
CONT No
WP No P13–03

HIGHWAY 400 & LINE 5
OVERHEAD SIGN SUPPORTS
BOREHOLE LOCATIONS PLAN

SHEET

URS

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕	Borehole
⊕	Borehole (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▽	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
SLAT 57W–01	228.2	4 882 249.2	294 702.6
SLAT 58W–01	229.2	4 882 399.8	294 676.2
SLAT 62–01	229.5	4 882 940.5	294 587.3
14–161	228.5	4 882 669.2	294 673.4
14–162	233.3	4 882 891.0	294 647.4

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31D-611

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	SKP	CHK	SKP	CODE		LOAD	DATE JUL 2015
DRAWN	AN	CHK		SITE		STRUCT	DWG 1C

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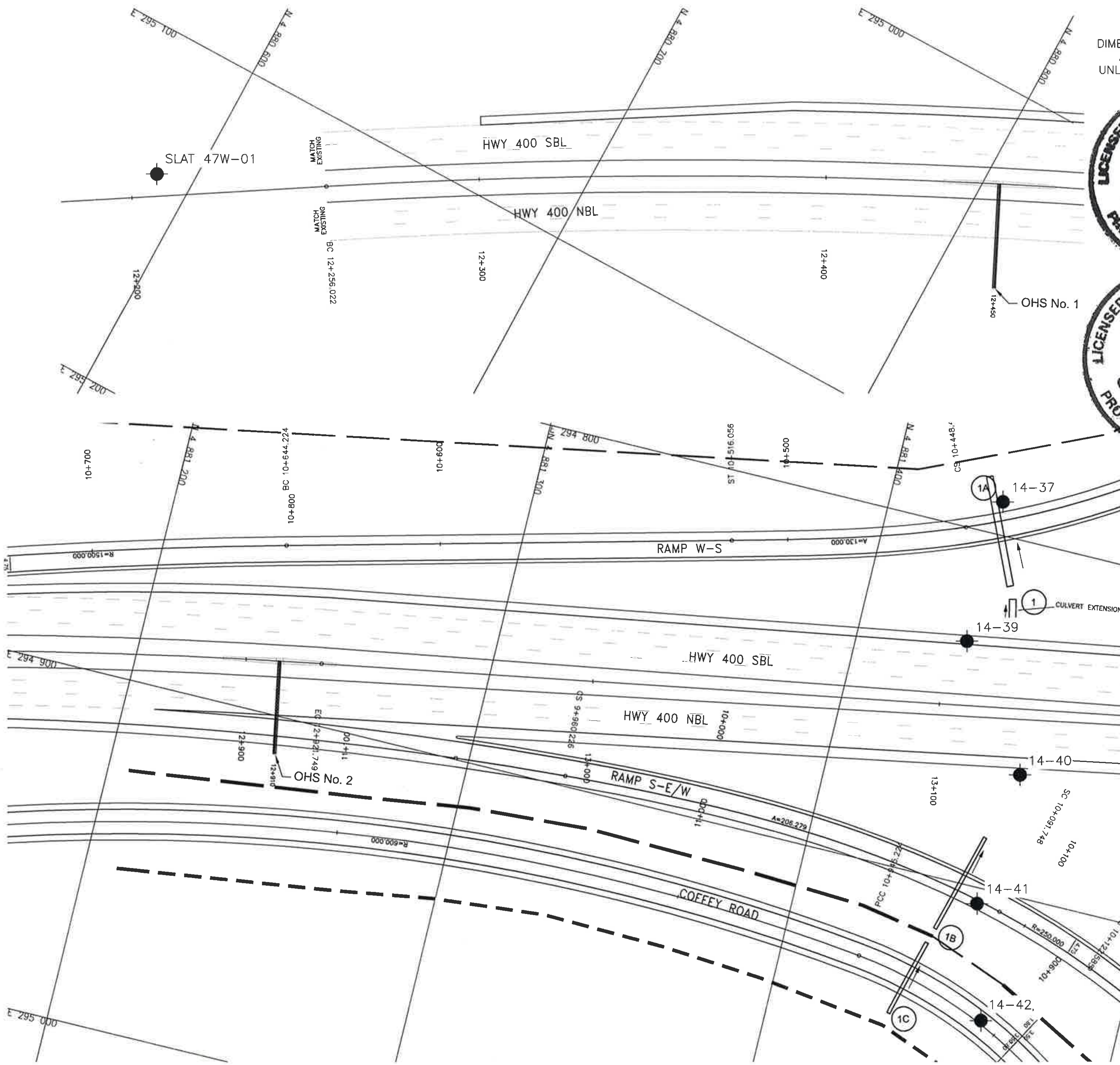


PLAN

25 0 25 50m

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
S. RANG
Jul 28/15
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
July 28/15
PROVINCE OF ONTARIO

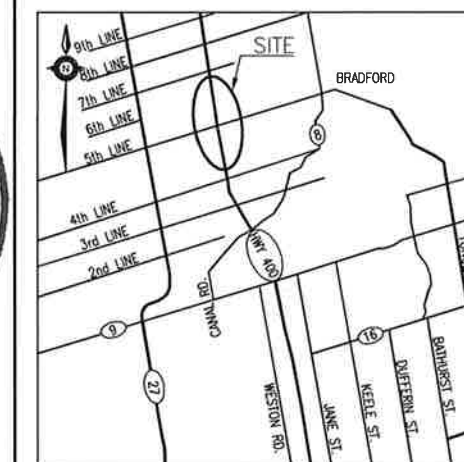
CONT No
WP No P13-03

SHEET

HIGHWAY 400 & LINE 5
OVERHEAD SIGN SUPPORTS
BOREHOLE LOCATIONS PLAN

URS

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

	Borehole
	Borehole (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
SLAT 47W-01	227.2	4 880 589.8	295 140.9
14-37	225.3	4 881 431.9	294 790.5
14-39	226.6	4 881 431.3	294 831.9
14-40	226.2	4 881 455.2	294 865.6
14-41	224.2	4 881 451.9	294 904.5
14-42	224.3	4 881 460.9	294 936.9

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31D-611

REVISIONS

DATE	BY	DESCRIPTION

DESIGN SKP	CHK SKP	CODE	LOAD	DATE JUL 2015
DRAWN AN	CHK	SITE	STRUCT	DWG 1C

FILENAME: H:\Drafting\19\4406\15\xxd0615-BoreholePlan (Overhead Signs).dwg
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Appendix D

Comparison of Foundation Alternatives

COMPARISON OF ALTERNATIVE CULVERT TYPES

Proposed Works	Concrete Box (Closed) Culvert	Concrete Open Footing Culvert	Circular Pipe (concrete, steel, HDPE) Culvert
Culvert Replacement	***Advantages:*** i. Relatively rapid installation and less disturbance to subgrade soils if precast units are used. ii. Less requirement for soil geotechnical resistances as loading is spread over a larger width. ***Disadvantages:*** i. Culvert subgrade preparation and bedding placement must be carried out in the dry. Dewatering may be required.	***Advantages:*** i. Relatively rapid installation if precast units are used. ii. May have less environmental issues such as those involving spawning fish species. ***Disadvantages:*** i. Requires higher soil geotechnical resistances to support strip footings. ii. May require deeper sub-excavation and dewatering for strip footing construction.	***Advantages:*** i. May be installed using trenchless methods. ii. Steel and HDPE pipes may be more cost effective than concrete box and open footing culverts. ***Disadvantages:*** i. Steel and HDPE may not be as durable as concrete.

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Appendix E

List of OPSS Documents and NSSP Wording

1. List of OPSS Documents Referenced in this Report

- OPSS.PROV 1010
- OPSS.PROV 501
- OPSS.PROV 804
- OPSS.PROV 1205
- OPSS.PROV 539
- OPSS 902
- OPSS 903
- OPSD 3000.100
- OPSD 803.010
- OPSD 802.010
- OPSD 802.030
- OPSD 802.031

2. Suggested Text for NSSP on:

"Augered Caisson Construction for Tri-Chord Sign Support Foundations"

The Contractor is advised that variable types of subsurface materials may be encountered at the locations of the sign support foundations. For additional information regarding subsurface conditions, the Contractor is referred to the Foundation Investigation Report.

For bidding purposes, the Contractor shall assume the following:

1. The subsurface conditions at an augered caisson location are the same as those encountered in the borehole closest to the subject caisson location.

2. Cobbles may be encountered within the glacial till deposits, and obstructions including rubble and cobbles may also be present within the embankment fills. The soil matrix is anticipated to become harder or denser with depth. Caisson installation equipment must be able to dislodge, handle, remove or otherwise penetrate these obstructions and hard/very dense layers.

3. Water seepage and/or soil sloughing into the caisson hole will occur from existing fill and cohesionless soils at some locations. The cohesionless soils would be susceptible to disturbance under conditions of unbalanced hydrostatic head. Temporary liners shall be available on site, or be made available on very short notice, to support the caisson sidewalls and provide seepage cut-off where required. All concrete should be placed in the dry.

The Contractor is responsible for constructing the tri-chord sign support foundations without disturbing the material at the sides or bases of the foundations.